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Evaluation of Alternative Interment Methods for National Cemeteries

Research Study Report

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EVALUATION OF ALTERNATIVE INTERMENT METHODS FOR NATIONAL CEMETERIES

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EVALUATION OF ALTERNATIVE INTERMENT METHODS FOR NATIONAL CEMETERIES

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INTRODUCTION

The Veterans Administration through Public Law 93-43 became responsible for the management of virtually all national cemeteries in 1973. The National Cemetery System (NCS) of the Department of Memorial Affairs (DMA) of the Veterans Administration (VA) operates over one hundred cemeteries in 37 states and Puerto Rico. The Veterans Administration has been continuing the past policy of offering a dignified burial for all veterans and their dependents without discrimination while seeking constantly to make their interment methods more cost effective.

The current standard gravesite in a national cemetery is 50 square feet (5 feet wide by 10 feet long). Normally the grave for the initial burial is dug seven feet deep and a liner of concrete or other durable material is furnished to protect the casket placed at that depth from collapse. The second burial which occurs in one of every three gravesites consists of another liner and casket placed above the first liner. Liners were being furnished at most open national cemeteries in FY 1978, except where a reasonable price could not be obtained through competitive bidding or because of local custom. Another variation is the 6 feet wide by 10 feet long by 5 feet deep gravesite, which has been adopted under special environmental conditions demanding shallow depths of excavation.

The principal purpose of this study has been to determine which alternative methods of interment are appropriate for the National Cemetery System and are economically effective. Alternative methods are being employed by many private cemeteries and therefore it was in the private sector that a variety of alternative methods were observed and evaluated.

The methodology used in this study included several techniques for data collection; the collation and analysis of data; the development of appropriate prototypes; and the determination of their cost-effectiveness by comparing the present values of their life cycle costs for land, site development, interment structures, interments, and perpetual maintenance. Data gathering included a questionnaire that was sent to 77 national cemeteries currently providing interment services. Their responses, which were used as a basis for this study, reflected statistical, environmental and economic data pertaining to the period from October 1977 to September 1978; that is, fiscal year 1978. Much statistical data was furnished by the Veterans Administration; other data was obtained through independent literature search and personal contacts. Finally visits to 8 national cemeteries spanning a wide range of environmental conditions and 22 private cemeteries in their vicinities were made by representatives of the consultants' study team and the research staff of the Veterans Administration.

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1 EXECUTIVE SUMMARY

Broadly speaking, the purposes of this study have been to assess the efficiency of certain existing procedures used for inground interments and to evaluate the appropriateness and cost effectiveness of alternative methods of interment.

One of the most difficult problems that has to be overcome in both the private sector and national cemeteries is the negative visual impact of grave sinkages, due either to inadequate tamping procedures or the collapse of unprotected caskets and non-durable liners. In order to overcome these problems and improve the overall appearance of national cemeteries, two approaches have been recommended. The first is to institute and evaluate an interim program requiring perimeter tamping around liners followed by backfilling with mechanically-tamped layers not exceeding 30 inches in depth. This recognizes that the existing regulations calling for tamped 12 inch layers are impractical for many cemeteries but that the common procedure of tamping 5 feet of backfill from the surface has little hope of achieving adequate compaction. The second approach is to continue the policy of furnishing durable liners unless they are prohibitively non-cost effective or collapses are demonstrably not a noticeable problem.

It is further recommended that the cost of the program for furnishing liners be minimized by attempting to use the less expensive one-piece bell liners rather than box and lid liners wherever soil conditions permit and, for cemeteries with less than 5 interments average per day, by attempting to negotiate contracts for liners delivered only—to be placed by cemetery forces. The latter should ultimately be adopted as a procedure in any cemetery where liners can be placed by interment personnel without increasing the size of staff.

The study concluded that the 5'x10'x7' deep gravesite should be retained as the basic structure of the National Cemetery System. It was judged to be uniquely suited to sequential excavation of graves in most soils encountered while being the narrowest gravesite that will provide adequate space for third and fourth interments in the same gravesite without resorting to very deep excavations at the 9' deep level. There is no need for reserving gravesites for possible use by dependents and the need for disinterment is rare. All narrower gravesites require either a 3 layer system or a reservation system to handle third interments and would very likely result in increased numbers of disinterments to accommodate unanticipated third interments. The reduction in costs that would be achieved by the adoption of narrower gravesites is estimated to be perhaps $15,000,000, a savings that would be realized gradually, beginning several decades from now, if one-third of the available gravesites in the system could be converted in sensible fashion to 3.5'x9.5' gravesites. We do not feel that that is compelling enough reason to adopt a system nation-wide that is inherently inflexible, implies a system-wide reduction in benefits, and would undoubtedly result in offsetting increases in costs for administering a reservation system or executing a 3-layer grave system and in an increased number of disinterments.

A 6'x10'x5' deep gravesite, as presently used, is the most reasonable alternative where 7' deep excavations are impractical because of very difficult soil conditions. In order to be cost effective, the switch to 6'x10' gravesites should only be made because the manhours per interment in making 7' deep excavations are too high and can be reduced to a reasonable number by interring at the 5' level.

In either the 5'x10'x7' or 6'x10'x5' gravesite there may be reason in certain areas for reducing the depth of burial to avoid difficult excavating problems. The 28 to 32 inches of soil cover that usually occurs over the top liner would then be reduced. It is recommended that 18 inches be adopted as the minimum standard of cover for maintaining a uniform, healthy lawn above the liners, but that in moderately well-draining, friable soils the minimum cover be permitted to be reduced to 12 inches if a test plot in situ establishes that the appearance of lawn will not be spotty and that the liners supplied can withstand the specified axle load. It is further recommended that the liner specification provide for a test load using an 11,000 lb. axle rather than a 9,000 lb. axle in order to provide a factor of safety and that the test be conducted under conditions of saturated soil in order to simulate the most disadvantageous natural conditions that oecur. The standard depths of burial should not be reduced in areas where durable liners are not provided so that arching action between grave walls has a chance to develop and minimize the load on caskets.

Alternative methods of interment should be considered under the conditions that they are cost effective and can be offered to all veterans without discrimination. The Cost Effectiveness Ratio method evolved in this study compares the present values (or present worth) of the life cycle costs of any two alternatives. Included in the life cycle costs are land, site development, interment structures and markers, interments, and perpetual maintenance. Simplified tables and charts have been included for rapid and approximate, but reasonably accurate, comparisons.

Narrower inground gravesites—either 3.5′x9.5′x7′ deep gravesites or preplaced double depth lawn crypts—should be considered for any cemetery in its closing decade in order to increase gravesite densities and extend its useful life if it is considered unfeasible to construct a replacement cemetery in that area during that decade. Lawn crypts would double the number of interments provided by 5′x10′ gravesites, and 3.5′x9.5′ gravesites (the minimum dimensions practical for many national cemeteries) would increase interments 50%. Either method requires the reservation of an additional gravesite where a third interment is judged probable or, alternatively, a three layer system beginning at 9′ of depth. Which of these two narrow gravesite interment methods will be the more cost effective will vary from cemetery to cemetery. The capital cost of construction for preplaced crypts, however, is of the order of magnitude of seven times larger than for 3.5′x9.5′ gravesites. If used in a cemetery's closing decade, the cost effectiveness of lawn crypts can be assured by reassigning surplus interment manpower to site rehabilitation work, as is common practice in those closing years. When narrower gravesites are employed in such a limited sense the problems associated with the need for a reservation system or 3-layer system should be manageable and be viewed as acceptable—considering the extension of benefits achieved.

Of the two methods for achieving narrower gravesites, preplaced double depth lawn crypts are very likely to be better accepted by the public and veterans' organizations, who may view them as a more efficient method of interment and one not necessarily involving a diminishing of benefits. The use of lawn crypts has already gained substantial acceptance in the private sector as being equal, or perhaps superior, to standard inground burial. Accordingly, where it is cost effective to do so and a satisfactory management plan can be developed for handling third (and fourth) interments, it may be appropriate to consider the adoption of preplaced double depth lawn crypts for large remaining sectors of newer cemeteries. In order to realize the cost effectiveness implied by their potentially greater interment productivity rate, the existing cemetery staff would have to be reduced and tailored to the specific requirements of lawn crypts.

It is recommended that follow-up studies be made to determine the life cycle costs of flat and upright markers including not only first costs, realignment costs, and the impact on maintenance but also the cost of replacing deteriorating markers and those damaged by cemetery vehicles. Present evidence does not lead us to conclude that either marker will be significantly more cost effective than the other when all factors have been considered. There are several conditions under which we recommend that only flat markers be used: gravesites 4 ft. wide and narrower;

cemeteries where permanent irrigation systems have been installed; and in the new national cemeteries designed as informal memorial parks.

Garden crypts are not likely to be cost effective except possibly to inter in difficult terrain where inground methods would be very costly. Again, this would be most appropriate in the closing decade in the absence of any alternative inground burial areas in reasonable terrain. The concept of remote memorialization would very likely have to be adopted since it would permit: crypts to be offered without implied discrimination as to position in the structure; full utilization of crypts; lower unit costs; and rustic exterior designs that are more able to be adapted to the informal memorial park character of newer cemeteries.

Use of obstructed gravesites for the inground burial of cremains should continue to be the standard for the National Cemetery System. Only when the demand for cremains interment begins to exceed the availability of obstructed sites will it normally prove cost effective either to subdivide 5′ x 10′ or 6′ x 10′ gravesites (to create 5′ x 5′ or 6′ x 5′ cremains plots) or to add columbaria niches to existing or planned building walls and retaining walls. Where such an addition of niches is feasible, it will normally be more cost effective than to subdivide 5′ x 10′ or 6′ x 10′ gravesites. On the other hand, it will normally be less cost effective to construct walls for the specific purpose of providing columbaria niches than to subdivide 5′ x 10′ or 6′ x 10′ gravesites. However, columbaria walls represent an excellent strategy for extending the useful life of a cemetery where the demand for cremains interment is high and might be considered for that purpose if the premium cost for their construction is relatively small.

Finally, continued research has been recommended to determine the full cause for the wide range of interment and maintenance productivity rates measured for 22 sample cemeteries—with concentration on the lower end of the productivity scale. Such research should consider, in addition to the environmental and operations factors reviewed in this study, an evaluation of the impact of cemetery administrative procedures on efficiency and an evaluation of the relative quality of maintenance achieved for the manpower expended.

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2 CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusions

(1) **Bell-shaped durable liners, concrete or fiberglass, cost less than concrete box and lid liners and are simpler and less costly to set in place. Observations indicate that they perform their intended functions of preventing collapses and keeping water away from the casket as well or better than box liners with lids. One reservation concerning their use occurs under conditions of unstable collapsing soil, usually sand. When inadvertent collapses occur during or after placing of the casket, a great deal of time-consuming hand labor is required before the bell can be set properly.**

(2) **Purchasing liners for later installation by national cemetery crews may produce significant savings under conditions where this can be accomplished without adding personnel. We estimate that this may be the case where there are fewer than 5 interments (average) per day, perhaps higher where bell liners are used. Added personnel may be required at higher or lower interment rates depending on actual environmental conditions, which are likely to vary considerably from one cemetery to another. It is when the interment rate is low that the portion of the total charge made by an outside contractor for setting the liners in place will be relatively high per unit and that the greatest savings per unit can be achieved.**

(3) **The overall appearance of a national cemetery where sinkage problems are severe is poor, regardless of the cemetery director's efforts to keep apace of needed gravefilling and headstone realignment operations. Sinkages additionally create problems in terms of visitor safety, difficult mowing conditions and equipment damage.**

(4) **Most national cemeteries visited during the study were not tamping backfill placed around liner perimeters or tamping the overburden backfill in 12 inch layers as prescribed by regulations—presumably because it is too time-consuming a process. Most compaction is attempted from the surface, in which case vibratory compactors appeared to be the most effective. In a few instances water was applied but the policy of puddling or irrigating freshly dug grave areas is generally objected to by the public. The overall quality of compaction of grave backfill in national cemeteries—although there are exceptions—appears noticeably poorer than in the private sector.**

(5) **A minimum depth of 18 inches of soil cover is preferred in order to guarantee a healthy lawn with uniform appearance, although it is clear that in some well-draining soils this could be reduced without detriment to 12 inches if needed to reduce grave depths where difficult excavation conditions exist. The minimum depth of soil cover required to avoid damage to caskets and liners depends principally on the saturated shearing strength of the soil and the structural design of the caskets and liners. Functional tests *in situ* can establish the adequacy of the designs. It is a relatively simple matter to achieve increased liner load capacity but not simple at all to require or test for adequate casket load capacities.**

(6) The specification for testing the load capacity of liners should be modified to require a safety factor of at least 1.20 and to require testing under a saturated soil condition, the condition most critical for concentrating and maximizing the impact of wheel loads.

(7) The most prevalent gravesite size, 5'x10'x7' deep, is the narrowest gravesite that will permit sequential excavation of graves in most soils without the intervening wall of soil collapsing. In borderline soils where collapses are occasional, the situation can be improved by a "leap frog" method, always leaving one unexcavated grave between adjacent open graves. In severe cases of collapse, such as in sandy sites where all 7 ft. deep excavations collapse to some extent because of the cohesionless zone that usually lies below a more coherent surface layer, it is preferable to use 6'x10'x5' deep gravesites and excavate the adjacent halves of gravesites for first interments—thereby eliminating all narrow walls of soil. It is not reasonable to use less than a 6 ft. wide gravesite for burials in a single layer at the 5 ft. level since the probability of a second interment is 1 in 3; accordingly, the probability of having two adjacent gravesites with two interments each is high enough to warrant provision of a full 3 ft. wide space for each potential interment.

(8) Flat markers cost less than upright markers and are more suitable for the emerging informal memorial park designs in new cemeteries. They are more or less mandatory on narrow gravesites because of the crowded appearance upright markers would have. Inasmuch as upright markers tend to interfere with irrigation spray trajectories and uniformity of distribution, flat markers are more suitable wherever irrigation systems are to be installed. Although detailed data are not available, it appears as if there is no appreciable difference in maintenance trimming costs between upright and flat markers. There should be a savings in maintenance mowing costs with the flat markers if wide tracked gang mowers are used; several instances were observed, however, where flat marker areas were still being mowed with the narrower machines required between rows of upright markers. Flat marker areas in one sense require more care than upright marker areas because the open vistas they create make any sinkages that do occur rather obvious.

(9) The private sector, under the pressure of the scarcity of land for cemetery purposes and rising land costs, is adopting a wide range of alternative interment methods designed for increasing the gross densities of interments and prolonging the life of cemetery land already owned and developed. This leads them into more costly methods, the cost of which can be competitively offset by increasing prices so long as the value of land, or its replacement cost, continues to rise—making inground interments more costly. The private sector solves any discrimination between customers as to the quality and location of interment facilities provided by using a differential price structure—a practice having no pertinence in national cemeteries.

(10) There did not appear to be any remarkable difference in efficiency between the procedures used in the private sector and in national cemeteries; but they are difficult to compare directly because of differences in the procedures they employ. The private sector spends more time on committal service setups; requires less layout work because the majority of burials occur within areas where

markers already exist; generally uses the same personnel to excavate graves well in advance and backfill them following interment; usually lowers caskets with a mechanical lowering device; and, has considerably less involvement with grave markers. National cemeteries are required to perform much more layout for new sequential burial areas; usually have different personnel simultaneously excavating in one area and backfilling in another; many still use up to 6 men to lower caskets manually; and, are wholly responsible for setting markers.

No attempt was made during this study to evaluate the efficiency of the private sector quantitatively. An earlier study (Ref. 2.1) which compared the National Cemetery System with the large Archdiocese of Chicago private system, found a productivity of 187 interments per man-year in the private sector and 159 interments per man-year in the national cemeteries—an 18% difference. If anything appears to characterize the difference in systems best, it is that the private sector, compared with national cemeteries (1) uses fewer personnel to perform a greater variety of tasks and (2) is able to keep experienced staff longer. The first difference does not necessarily imply greater efficiency because the larger number of national cemetery personnel may also be performing correspondingly greater maintenance duties when not interring. The second difference does seem to affect efficiency and the quality of lawn care.

(11) Nine interment methods (alternatives 0 through 8) are judged appropriate for use in national cemeteries under the conditions that they prove cost effective and are offered without discrimination to all veterans. Their principal advantages and disadvantages are listed below.

	Interment Method	Advantages	Disadvantages
	Casketed		
(0)	5'x10'x7' Gravesite with liner	Can accommodate third interment. Minimizes sinkages.	Liner adds cost
(1)	Gravesite without liner	Minimal cost	Usually severe sinkage problems
(2)	6'x10'x5' Gravesite with liner	Overcomes deep excavation problems	Uses 20% more land than (0)
(3)	3.5'x9.5'x7' Gravesite with liner	Least cost. Uses 33% less land than (0)	Requires reservation system for anticipated third interment. When unanticipated, requires disinterment of first two. Also, see Note 1
(4)	Preplaced Double Depth Lawn Crypt	Less interment disturbance. Uses 53% less land than (0)	High initial cost. Requires reservation system for anticipated third interment. Also, see Note 1
(5)	Garden Crypts	Uses 69% less land than (0)	High initial cost. Remote memorialization. Also, see Note 1
	Non-Casketed		
(6)	Inground Cremains—Obstructed Gravesite or Subdivided Gravesite (5'x5' or 5'x6')	Minimal cost	Subdividing consumes land usable for casketed interments
(7)	Columbaria Walls	Uses 51% less land than (6) if 5'x5' plot	High initial cost
(8)	Add-on Columbaria Niches	Uses no land	Moderate initial cost

Note 1: Method possibly viewed as discriminatory with respect to benefits offered unless no other alternatives are available in a given cemetery.

(12) Twenty-two sample national cemeteries spread geographically throughout the National Cemetery System (including Hawaii and Puerto Rico) which handled 80% of all interments made in FY 1978 had annual interment rates ranging from 143 to 9,817 and averaged 940 excluding the cemetery with the highest rate. The average rate for this most active group of cemeteries is equivalent to approximately 4 interments per day, whereas the maximum was 43 interments per day. Only 8 cemeteries had 5 or more interments per day.

(13) The average annual interment salary in FY 1978 throughout the sample national cemeteries varied from $9,700 to $21,000 and averaged $14,400—a range from 64% to 144% of the average. The average annual maintenance salary in FY 1978 varied from $9,200 to $20,300 and averaged $13,000—a range from 70% to 156% of the average.

(14) On the basis of a national average interment salary ($14,400) and not including the purchase of topsoil, the cost of making interments in FY 1978 varied from $67 to $183, averaging $120. The cost of interments was found on the average to be equal to the number of interment employees per annual interment multiplied by $19,500 ($16,000 for salaries and benefits, $3,500 for materials and equipment). The costs of cemetery administration and conducting the committal service are not included in these unit costs of interment.

(15) In the sample national cemeteries the interment productivity rate varied from 99 to 338 annual interments per man-year, averaging 176. By correlating environmental and operational factors with the ranking of productivity rates, some general guidelines were indicated:

(a) With less than 500 annual interments and a significant occurrence of rock in excavations, the productivity rate will probably lie between 100 and 160 interments per man-year.

(b) With more than 500 interments, no rock, and most of the cemetery flatter than 5% slope, the productivity rate will probably lie between 180 and 300 interments per man-year.

(16) On the basis of a national average maintenance salary ($13,000) and not including the repair of sinkages, the annual cost of routine maintenance per maintained acre in FY 1978 varied from $1,300 to $6,500/acre, averaging $3,000/acre. In calculating maintained acres, an acre not developed into gravesites with markers was counted as one-half acre in order to take into account its lesser cost impact. The annual cost of maintenance per acre was found on the average to be equal to the number of maintenance employees per maintained acre multiplied by $17,000 ($14,400 for salaries and benefits, $2,600 for materials and equipment).

(17) In the sample cemeteries the maintenance productivity rate varied from 2.4 to 14.9 maintained acres per man-year, averaging 6.8, not including man hours devoted to sinkage repairs. By correlating environmental and operational factors with the ranking of productivity rates, some general guidelines were indicated:

(a) Under conditions of severe drought or intense rainfall, especially when a cemetery is undertaking a major rehabilitation program, it will probably have a productivity rate between 3 and 7 acres per man-year. If it also has a growing season of 10 months or more it is likely to have a productivity rate between 3 and 5 acres per man-year.

(b) If there are less than 25% reopeners under conditions where there is no major rehabilitation, severe drought or intense rainfall, a cemetery is likely to have a productivity rate between 7 and 14 acres per man-year.

In our opinion, the very wide range in maintenance unit costs and productivity rates throughout the system cannot be explained fully and satisfactorily by environmental and operational factors. We believe that the relative quality of maintenance achieved in these cemeteries plus the methods of management used have significant impacts on the annual costs per acre.

(18) The manhours required to correct sinkages (refilling graves, raising and realigning headstones, etc.) varied greatly throughout the sample cemeteries. Their sinkage factors, which are the ratios of total manhours for maintenance (including sinkages) to those manhours required for routine maintenance (excluding sinkage repair work) varied from 1.02 to 2.22, averaging 1.26. Nine out of 22 cemeteries were reported to have fallen behind their planned repairs so that, in calculating the sinkage factor, the estimated manhours to complete all planned sinkage repairs were used. The sinkage factor is a fairly direct measure of the extra maintenance effort required, above routine maintenance, to counteract the settlements related to casket or non-durable liner collapses—but partially reflects the quality of tamping grave backfill and variations of soil conditions.

(19) Interment and maintenance productivity rates for alternative methods of interment, as set forth in Table 9-1 and developed from observations made during visits to private sector cemeteries, indicate that all of the methods involving preconstruction of crypts and niches require sharply reduced interment manhours and most require sharply reduced maintenance manhours.

(20) The Cost Effectiveness Ratio, which is the ratio between the present values of the life cycle costs of a control alternative and any other alternative, was found to be the most useful measure for determining cost effectiveness. The economic model used considers the costs covering up to 5 years of interments under any alternative. The components of cost included are the construction (or purchase) of interment structures and markers; land; site development (excluding buildings); interments (excluding administrative costs); and maintenance for 50 years.

(21) Reopeners, which are taken to be 33-⅓% of first interments, have different economic impacts on different alternatives. With preplaced double depth lawn crypts and columbaria niches, the space for a second deceased has been preconstructed whether or not it will be used. With inground liner burials and the prototype garden crypts described in Chapter 5, an additional interment structure or burial unit is only committed for each reopener at the time of burial. The latter two methods therefore achieve virtually 100% utilization of interment structures while the former two methods achieve only 67% or less utilization.

(22) The average densities of gravesites (or crypts or niches) per gross acre, evolving from an evaluation of appropriate casketed prototype methods of interment, varied from 427 gravesites per acre for inground 6′x10′ gravesites to 1,650 burial

units/acre for garden crypts. For non-casketed interments, densities per gross acre varied from 1,025 gravesites per acre for inground 5′x5′ gravesites to 2,100 burial units per acre for columbaria walls. In each instance it was assumed that 1 net acre of burial site would require the development of 1.70 gross acres of cemetery land.

(23) Using $15,000 per acre for land; $35,000 per acre for site development; an estimated current system-wide average value of $3,700/acre/yr. for routine maintenance costs (excluding serious sinkage repairs); current average unit costs for the various types of interment structures; and average unit costs of interments (depending on average productivity rates in the case of inground interments) the following conclusions were reached concerning the cost effectiveness of the prototype methods judged appropriate for use in national cemeteries:

(a) 5′x10′ gravesite - liners compared with no liners

Unless the cost of liners is very low and the interment productivity rate very low, it is not strictly cost effective to use liners to offset the increased cost of maintenance incurred by repairing sinkages. On the other hand, some value must be assigned to the improved appearance of cemeteries when liners are used.

(b) 6′x10′ gravesite compared with 5′x10′ gravesite

Unless there is an increase in productivity rate in adopting the shallower 6′x10′ gravesite, it will not be cost effective because it uses more land than the 5′x10′ gravesite. However, the usual reason for adopting it is the presence of collapsing sands, high rock ledge, high groundwater, and other ground conditions that tend to decrease the productivity rate of the deeper 5′x10′ gravesite.

(c) 3.5′x9.5′ gravesite compared with 5′x10′ gravesite

Assuming the same productivity rates, the 3.5′x9.5′ gravesite will always be more cost effective. This must be weighed against its disadvantages in flexibility of handling third interments and the possible charge that this represents a serious downgrading of benefits.

(d) Preplaced double depth lawn crypts compared with 5′x10′ gravesites

There will be many situations where preplaced lawn crypts will be more cost effective. The principal determining factor will be the current unit cost of crypt construction in any locality. The savings in present value of life cycle cost per veteran family unit must be weighed against the lack of flexibility in handling third interments and the shift to high capital construction cost funding.

(e) Garden crypts compared with 5′x10′ gravesites

Even with the economical design features proposed for this prototype, it is difficult to see under current market conditions how garden crypts could ever be cost effective. They also involve a shift to high capital construction cost funding. Garden crypts might, however, provide a reasonable solution to the use of otherwise unusable steep land.

(f) Columbaria walls compared with inground cremains

While this prototype as evaluated was designed to be appropriate for new national cemeteries of informal design and is not as densely developed as possible, it is difficult to see under current market conditions how columbaria walls, even if designed to higher densities, could ever be cost effective when compared with subdividing 5′x10′ or 6′x10′ gravesites.

(g) Add-on columbaria niches compared with inground cremains

Where a structure designed to be suitably clad in stone has been planned to be constructed for another purpose, the addition of columbaria niches normally adds little cost and such niches will usually be cost effective. However, it will not be economically justified to construct add-on columbaria niches unless it is estimated that the number of cremains interments required for a particular cemetery will exceed the number of suitable obstructed gravesites that will occur during development.

2.2 Recommendations

(1) In order to keep its implied commitment to provide the veteran with a burial ground that confers honor on those interred there, the National Cemetery System should as a matter of policy continue to use durable liners for the interment of casketed remains so as to minimize the effect of sinkages unless (a) liners are prohibitively non-cost effective or (b) sinkages are demonstrably not a noticeable problem. Either of the following two rules should serve as guidelines:

(a) Whenever the Cost Effectiveness Ratio of interring without liners compared to interring with liners is less than 1.10, liners should be used to achieve a better appearance, or

(b) Whenever the existing sinkage factor, as defined in Chapter 8, of a cemetery exceeds 1.25, liners should be used to reduce sinkage problems.

(2) All cemeteries using liners should be encouraged to try bell-shaped liners if they can achieve a savings in cost, but to test them *in situ* before agreeing to a contract. Generally their use will not be suitable in cemeteries suffering from conditions of unstable collapsing soil.

(3) Cemeteries where there are fewer than 5 interments average per day should be directed to attempt to negotiate contracts, for a half year or longer, for liners delivered—to be placed by cemetery forces. The intent of this directive should be to accomplish the reduction in outside contract costs without increasing staff. The manhour records should be reviewed at the end of the contract period to determine if the increase in manhours recorded, if any, for interments, is less than the equivalent of the manpower usually furnished by the outside liner contractor—in most cases one man essentially full time. If the manhour increase is less, the program should be judged cost effective and continued; if greater, it should be abandoned.

(4) An effort should be made to improve tamping quality throughout the National Cemetery System. The governing regulation requiring tamping of backfill in 12 inch layers is impractical for most larger national cemeteries. On the other

hand, a 5 ft. depth of backfill, as is common in first interments, cannot be satisfactorily compacted from the finished surface. The following interim standard is suggested:

(a) A light cover of backfill shall be placed and manipulated into the perimeter spaces between liner and graveside and tamped tight, using poles with tamper ends, or by other means found suitable by the cemetery director. Where the existing soil is too difficult to manipulate, consideration should be given to using sand for this purpose—assuming a reasonably inexpensive supply is available.

(b) Place layers of backfill not exceeding 30 inches in depth and tamp each such layer thoroughly with a mechanical vibrating tamper attached to the moveable arm of a piece of equipment in such manner as to permit the tamper to be lowered into the partially backfilled grave and applied carefully—and without exerting excessive force—over the entire surface of backfill, or by other means found suitable by the cemetery director.

In addition, in cemeteries having irrigation systems and relatively friable soils that tend to settle following intense rainstorms despite how well tamped they may be, the cemetery director should simulate such a rainstorm by turning on the irrigation system, if it does not rain with any intensity in the period between the completion of burials in a new section and the follow-up surface finishing work. Preferably this should be done during hours when the cemetery is closed so that workers and occasional visitors can occupy those areas without encountering muddy conditions.

Finally, it is recommended that a follow-up report be obtained one year after the interim program has been started—in which the cemetery directors report on their actual methods of tamping; on any improvements observed; and how that is being reflected in the change in manhours required to inter and to repair sinkages *in areas where liners are in use.*

(5) The minimum depth of soil cover over liners should normally be 18 inches in order to achieve and maintain a uniform lawn appearance. In moderately well-drained, friable soils this depth may be reduced to 12 inches in order to minimize difficult excavation problems, provided that:

(a) It can be demonstrated in a test plot with liners in place at minimum cover—in one third of the gravesites for 5'x10' gravesites and in two thirds of the gravesites for 6'x10' gravesites—that a satisfactory lawn can be maintained, and

(b) It can be demonstrated by *in situ* test that the liners to be used will withstand the specified design load under those conditions.

The minimum depth of soil cover over unprotected caskets should be 30 inches in order to permit the backfilled soil to form an arch against the unexcavated walls of the grave and minimize the loads delivered to the casket.

(6) Specification X-1708C (June 1, 1979), "Liners, Grave, Concrete and Thermoplastic/Thermosetting" should be modified in two respects:

(a) The *in situ* design load should be increased from an axle load of 9,000 lb. to 11,000 lb., permitting a factor of safety of 1.22 for the 9,000 lb. axle design load—which is very close to the actual weight of the heavier backhoes being used in cemeteries.

(b) Require the *in situ* functional test to be performed following thorough saturation of the ground above the liner, thereby simulating conditions following a heavy rain and the condition of least shearing strength that is usually the most critical for concentrating the impact of applied loads.

(7) The Veterans Administration should retain the 5'x10'x7' deep gravesite, with the 6'x10'x5' deep gravesite as an alternative where 7' deep excavations are not reasonable, as the basic structure of the National Cemetery System. The 5'x10' gravesite is the narrowest gravesite that can be excavated sequentially without collapsing side walls in most of the soils encountered throughout the system—although in some areas a "leapfrog" system must be used in lieu of sequential digging in order to minimize collapses. Given the rare occurrence of a third interment (estimated as having a probability of less than 4%), the 5 ft. wide gravesite also provides adequate space for third—and fourth—interments in the same gravesite. They can be accomplished without disinterment so long as the number of eligible dependents can be anticipated by the cemetery administration at the time of first and second interments. Graves narrower than 5 ft. can not accommodate third and fourth interments without serious encroachment on adjacent gravesites. Although narrower gravesites producing higher densities of gravesites per gross acre will surely be 5% to 15% more cost effective than 5'x10' gravesites (at equal productivity), we see no compelling argument for their adoption as a nation-wide standard. For instance, if 500,000 of the 1,500,000 remaining 5'x10' gravesites were able to be converted in sensible fashion to 750,000 3.5'x9.5' gravesites, the estimated savings would be $15,000,000 realized 30 to 40 years from now when the 250,000 extra graves created would not have to be constructed. There would be no savings in maintenance for many decades. Against this potential saving in the distant future, the Veterans Administration would have to weigh the implied system-wide reduction of benefits; the possible charge of discriminatory practice if the narrower gravesites are offered while burials are being completed in other sections of a cemetery using wider gravesites; the need for and cost of a reservation system or 3-deep burial system; and, the sharply increased probability of the need for disinterment because of unanticipated third and fourth interments. Nevertheless, wherever the need to extend the life of a particular cemetery becomes a clear imminent need, it appears appropriate to introduce narrower gravesites and rationalize their adoption on the basis of that need.

The 6'x10'x5' deep gravesite should continue to be approved as an alternative where 7' deep excavations are impractical because of high groundwater, high rock levels or collapsing soils. Normally the switch to 6'x10' gravesites will be cost effective because of the increased interment productivity rate that is achieved. Gravesites narrower than 6 ft. can not satisfactorily accommodate side-by-side interments in a single layer at the 5 ft. level because the relatively high probability (1 in 3) of a second interment would create an unmanageable encroachment problem.

(8) Additional research should be undertaken to determine the reasons for and remedies for the lowest productivity rates for interments and maintenance. The maximum number of manhours per interment encountered in a sample of 22 larger cemeteries was 178% of the average and the maximum number of manhours per maintained acre encountered was 283% of the average. These large differences could not be completely explained in this study by measurable environmental and operational factors. An evaluation of the effectiveness of individual cemetery administrations in controlling efficiency and the relative quality of grounds maintenance achieved must be considered in such additional research.

(9) Alternative methods of interment should continue to be considered for approval under special circumstances warranting their adoption under the conditions that:

(a) They are cost effective as defined by comparing their present values of life cycle costs using the Cost Effectiveness Ratio method and

(b) They can be offered to all veterans without discrimination.

This report contains tables of present values of life cycle costs and graphs comparing alternatives in which certain unit costs in the Cost Effectiveness Ratio formula that are actually variable have been assigned constant values equal to current average values for the National Cemetery System. These tables and graphs are useful for rapid comparisons of alternatives. Sensitivity tests made indicate that the probable error involved in any one comparison, because actual unit costs do not agree with those unit costs assumed in the tables and graphs, will not exceed 5%. However, it is essential to use the actual CER equation whenever approaching a decision.

This report also contains step-by-step procedures for making detailed economic comparisons of alternatives.

(10) Narrower inground gravesites should be considered for any cemetery in its closing decade in order to extend its useful life if it is considered imprudent or unfeasible to build a replacement national cemetery in its vicinity during that decade. Using 3.5′x9.5′x7′ deep gravesites will increase densities of gravesites by 50% (compared with 5′x10′ gravesites), while preplaced double depth lawn crypts will increase densities by 105%. Under conditions of competitively low lawn crypt costs and a relatively low inground burial productivity rate, the preplaced double depth lawn crypts will be more cost effective than 3.5′x9.5′ gravesites. They are twice as effective in extending the useful life of a cemetery.

Both methods have the disadvantage of requiring management of interments using a reservation system following these outlines:

(a) If the first interment is a spouse (especially a young spouse) or child, a second gravesite would be reserved.

(b) If the first interment is the veteran and there are no handicapped or chronically ill children, one gravesite would be assigned.

(c) Unanticipated third interments would require disinterment.

Alternatively, narrower gravesite systems could handle situations indicating a potential third interment by burying the first at the 9 ft. level in cemeteries where that is feasible and later adding interments at the 7 ft. and 5 ft. levels. For lawn crypts that would mean a separate section of triple depth crypts. Only in the case of a rare fourth interment would the gravesite be incapable of accommodating the entire veteran family unit. In many instances, a 3-layer system will not be feasible because of high rock or groundwater so that a reservation system will be the only answer.

Inasmuch as assigning a second gravesite and a formal reservation system is contrary to current policy and is difficult and costly to administer, it is recommended that whenever the cemetery director anticipates a third interment and 3-layer systems are not feasible, the first interment be made in a reserved section of the cemetery laid out in 6′x10′x7′ gravesites capable of receiving up to four interments at minimal cost.

It is recommended that the 3.5′x9.5′ gravesite system wherever adopted be excavated using an alternate day "leapfrog" system so as to avoid the psychological impact of a continuous open trench grave for sequential burials.

The capital cost of construction for preplaced double depth lawn crypts is of the order of magnitude of seven times larger than for 3.5′x9.5′ gravesites. This means that there has to be a corresponding decrease in interment costs, in addition to savings on land, site development and maintenance costs, in order to realize the cost effectiveness that may be indicated in a comparison with 3.5′x9.5′ or 5′x10′ gravesites. This should be easily achieveable if a cemetery is in its closing years because the surplus interment labor available can be reassigned to grounds rehabilitation work, which is customarily initiated when closing is approached. Otherwise there will have to be a significant reduction in interment staff in order to realize the implied productivity gain which makes preplaced double depth lawn crypts economically feasible.

Either alternative should be offered to all veterans without discrimination, that is, no choice of any other grave size except for reopeners, from the time it is initiated. If either has been initiated for the purpose of extending the life of a cemetery, and thereby extending the availability of interment benefits, that should be positively communicated to the veteran organizations and general public in that region.

It may be that the total conversion of a newer cemetery with a long remaining life to preplaced double depth lawn crypts will be fairly readily accepted by the public and veterans' organizations without its being viewed as a diminishing of benefits. We conclude this because this interment method may be readily accepted as a more efficient way of doing things and because it has already gained significant acceptance in the private sector. If it is cost effective to do so and a satisfactory management plan for handling third and fourth interments can be worked out, preplaced double depth lawn crypts should be considered.

(11) Flat markers should be used instead of upright markers under the following conditions:

(a) Wherever the intent is to create an informal memorial park design—the usual case in new cemeteries.

(b) Whenever a permanent irrigation system has been or will be installed, in order to avoid interference with spray trajectories.

(c) Whenever the width of gravesite is 4 ft. or less in order to avoid the appearance of a wall of upright stone.

Flat markers may also prove more cost effective than upright markers in the long run, but this was not clearly established by the data available from this study. Accordingly, a follow-up analysis is recommended that will include all elements of life cycle cost: first cost, replacement costs (due to damage and deterioration), maintenance and realignment costs, and the impact on lawn maintenance costs.

(12) Garden crypts should not be used unless they prove cost effective compared to inground burials, which appears very unlikely under current market conditions. The one situation where they may make economic sense is in steeply sloping portions of cemeteries in their closing years if a new national cemetery will not be available in that vicinity for less expensive inground burials prior to its closing. Under those conditions the present value of the life cycle cost per veteran family unit incurred in developing that steeply sloped portion of the cemetery with the most cost-effective feasible inground plan, presumably with very low densities and high site development costs, may exceed the present value of the life cycle cost per veteran family unit of garden crypts. Even then it is very likely that crypts with remote memorialization and sequential interment, similar to the prototypes described in this report, will have to be used to avoid discrimination, permit full utilization, and minimize the unit cost per crypt.

(13) The Veterans Administration should continue to use partly obstructed gravesites for the inground interment of cremains. Cemeteries that have a low demand for cremains interment, to the extent that the availability of obstructed gravesites exceeds the demand for them, should not consider any other alternative since the costs of land, site development and maintance have to be incurred whether or not those obstructed areas are used for cremains.

(14) Where the demand for cremains interment exceeds the availability of obstructed gravesites, columbaria niches should be added to as many building walls and retaining walls constructed for other purposes as makes sense from a design and operational view, provided that they prove more cost effective when compared with subdividing 5′x10′ gravesites into 5′x5′ cremains plots or 6′x10′ gravesites into 6′x5′ cremains plots. Only after that possibility has been exhausted should columbaria walls be considered. While columbaria walls would normally not be cost effective when compared with inground burial of cremains in subdivided 5′x10′ or 6′x10′ gravesites, it must be borne in mind that the cost to the government for interment in columbaria walls is only 40% ± of the cost for interment of casketed remains inground. Columbaria walls, in their least dense plan, use only half the land occupied by 5′x5′ cremains plots. Accordingly, they represent an excellent strategy for extending the useful life of a cemetery having a high demand for cremains.

(15) The basic data relating the unit costs of interments to the number of interments per man-year and the unit costs of maintenance to the number of maintained acres per man-year should be able to be extrapolated without significant error, through the use of the escalation indices proposed in Chapter 10, for a least five years. At that point, the basic data should be re-examined. With that in mind, we recommend that the record keeping of the Department of Memorial Affairs be examined to determine how best to collect and systematically record all the data other than direct salaries and benefits, such as the costs of materials, equipment, and equipment maintenance, that form a part of unit costs for interments and maintenance.

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3 INTERMENT METHODS AND PROCEDURES USED IN NATIONAL CEMETERIES

3.1 Extent of Active National Cemetery System

The National Cemetery System includes 108 national cemeteries; 20 soldiers' lots; 2 confederate plots in private cemeteries; 5 confederate cemeteries; 3 monument sites; and the congressional cemetery soldiers lot in Washington, D.C. Of the 108 national cemeteries, 50 are closed but 42 of the closed cemeteries have at least one burial space left. There are five new regional cemeteries, two of which have opened and one of which is planned to be opened in each of the next three years. Two or more regional cemeteries have recently been authorized. Eighteen cemeteries are nearing their ultimate capacity and will be closed during the next decade; six cemeteries are expected to close in the following decade; and, twenty-nine open cemeteries are expected to have gravesites available beyond the year 2000, provided the annual burial rate does not increase over its present level (Ref. 3.1). The burial rate during 1978 varied greatly from one cemetery to another. One had as many as 9,818 interments, making it probably the most active cemetery, public or private, in the country. On the opposite hand, there were fourteen cemeteries that had no burials in 1978, and twelve had ten or less. The most active portion of the National Cemetery System is represented by the 69 cemeteries which had burial rates from 10 to 1,000 and the seven with burial rates from 1,000 to 3,000 during 1978 (Ref. 3.2).

National cemeteries vary considerably in area as well as activity. The largest area allocated within the system is the newly-established cemetery at Calverton, Long Island, New York with its ultimate development of 902 acres. At the other extreme is the tiny cemetery at Hampton, Virginia with only .03 acre. The four other new regional cemeteries are all over 500 acres, but the largest older cemetery has about 480 acres (Ref. 3.3).

From 1947 to 1962 it was the policy of the Department of the Army to reserve an entire additional 5'x10' gravesite for each eligible member of a veteran's family following the death of the first eligible member of the family. At the end of FY 1978 there were approximately 75,500 reservations in 84 of the 108 national cemeteries, and more than half of these (40,437) were in 38 closed cemeteries (Ref. 3.1). There are two cemeteries, one open and one closed, that together account for almost 30,000 of the reservations.

At the end of FY 1978 there had been approximately 1.5 million interments made in national cemeteries since 1862. There were also another 1.5 million gravesites estimated to be available beginning in October 1978, not including the 75,500 reservations. The estimated number of living veterans in civilian life at the end of May 1979 was 30 million while the number of veterans in civilian life buried in national cemeteries over the past five years has averaged 26,600 persons, and the number of dependents buried averaged 10,000 (Ref. 3.4). The total number of interments between 1973 and 1978 averaged 36,800 annually. At this rate, if the distribution of veterans who will eventually use the benefits available to them in the National Cemetery System matched the distribution of available gravesites, there would be 40 more years of space available in the system before the 1.5 million spaces are filled.

3.2 Inground Burials Without Durable Liners

Ever since the days when primitive peoples arranged flat stones around their deceased in a grave or interred the body in a hollow log, some form of container into which the remains are placed has been a common practice. Down through the years most inground burials have involved a coffin or casket, seemingly to protect the deceased from the dreaded elements of the earth. Only the cemetery keeper knew how temporary this method was—how the casket would sooner or later collapse and the ground above it sink.

In recent times the practice of placing the casket in a so-called "permanent" container has been introduced. Throughout the United States in most private cemeteries this method of using a relatively durable steel box or concrete grave liner is standard practice. The National Cemetery System adopted this technique officially in February 1976. In FY 1977, 24,081 interments utilized a government-supplied durable liner while 12,932 were made without a government-supplied liner (Ref. 3.5), although some of those interments were made with privately furnished liners. In FY 1978 thirty-one of the 105 cemeteries in the system had contracts to supply liners. Those 31 cemeteries provided for 77 percent of the total 36,734 interments made in that fiscal year, but not all burials in those cemeteries involved grave liners. In the sampling of 22 national cemeteries that were examined in detail during the study, 20,896 burials included a liner whereas 8,478 interments were made without liners, giving a ratio of 71% to 29% which probably is close to the national average for the most active sector of the National Cemetery System.

It can therefore be seen that inground burials without durable liners are still prevalent in the National Cemetery System. In the far South, with the exception of Texas, all active national cemeteries are burying without durable liners as are several cemeteries in California. Of the 34 cemeteries scheduled to remain open beyond the year 2000, fourteen did not have liner contracts in 1978, and of the fourteen, thirteen have a verv low annual burial rate, less than 100—or less than one every other day. The fourteenth is a special case, the national cemetery in Puerto Rico; although its burial rate exceeds 750 a year no durable liners are used. It was reported during the course of this study that grave liners are not used there because the tradition on the island is to bury in relatively durable metal caskets without the added protection of grave liners. In addition to a low annual burial rate which makes a liner contract impractical, or a local custom, a third reason for a cemetery not to use durable grave liners is that a reasonable unit cost can not be obtained locally through competitive bidding.

Wooden caskets placed unprotected in the ground or in wooden liners will sooner or later collapse and the result will be the sinkage of the gravesite. In most areas this first major sinkage seems to occur from 3 to 7 years after the burial is made. Once the gravesite has been filled in, retamped and resodded, the process of deterioration continues—so that another collapse, often more severe, may occur several years later, requiring further repair. In some instances there are further minor collapses. When a durable liner made of materials such as concrete or fiberglass is used, barring a collapse due to structural damage from equipment on the surface, sinkage due to deterioration of wood is deferred indefinitely.

When the initial interment is completed without a durable liner in a 5′x10′ gravesite, the second burial must, of necessity, be without a liner for the weight of the liner placed over lower casketed remains will tend to crush them. In cemeteries where side by side interments are made possible by the 6′x10′ gravesite this problem ceases to exist.

The maintenance of the grounds and the alignment of the markers in cemeteries where inground interments without durable liners occur is more costly than where durable liners are used. Sinkages have to be repaired and both upright and flat markers have to be realigned more frequently. The mowing of grass is made more difficult because of the ground depressions; equipment can be easily damaged by rolling over sinkage areas; and there is greater jeopardy to the safety of the visiting public when sinkages are numerous. One circumstance which hastens the need for correcting collapsed graves and tilted markers over graves where no durable liners have been used is when heavy equipment such as dump trucks or backhoes are driven over these gravesites. Gravesites where liners are used will normally be able to withstand the impact of the heavy equipment.

The overall appearance of a national cemetery where sinkage problems are severe is relatively poor regardless of the success of the cemetery director's attempts at keeping up with needed repairs.

The advantages of burial without a durable liner are that the initial cost to the cemetery system is lower; the grave to be dug can be shallower, narrower and shorter; and the headstone can be set in relatively undisturbed ground if the casket is placed near the foot of a 5′x10′ site.

3.3 Inground Burials With Durable Liners

The practice of using a concrete box liner with a lid became popular in the United States after the Second World War. Of the twenty-two private cemeteries visited by the study team for this project all accepted durable liners or vaults and twelve made the use of them an absolute requirement for inground interments. The practice of using liners in national cemeteries was experimented with shortly after the Veterans Administration was given authority for them in 1973. However, the standard specification for liners to be used in any national cemetery was promulgated in February 1976 (Ref. 3.6). The extent of their present use has already been discussed.

The typical situation is that the national cemetery contracts for both furnishing and placing liners. One problem with this system is that of coordinating the work of the cemetery personnel with the liner contractor's men and equipment in the opening and closing of graves. Under the terms of the present contracts all but a few provide for the contractor to furnish, deliver and place the box in the grave previously dug and prepared by the cemetery work forces. Following lowering of the casket by cemetery forces, the contractor sets the lid, if any, in place. Cemetery forces then close the grave. Although this division of responsibility has some advantages, with respect to liner damage liability, it can and does affect the efficiency of interment operations. The problem arises because the cemetery director can provide control and supervision over his own labor force but is subjected to the efficiency of an outside contractor over whom he has less control. Also, because a contractor must always have his men and equipment present during all interment operations, the unit price of the liner is greater than if the liners were merely furnished and delivered—to be placed by cemetery forces.

The principal disadvantage to furnishing durable liners is their sometimes high initial cost. Studies have been made to find ways to reduce the cost. One possibility would be to require liners in the national cemeteries—but not as a provided benefit. Next-of-kin pay for liners in private cemeteries which require them so it might not be inappropriate to have them pay for this service in national cemeteries; however, it would mean removing a benefit already offered past veterans. Another suggestion to reduce costs is to have the cemetery work force install the liners. This would only materially reduce costs in cemeteries that could take on the work of placing liners without adding staff and equipment—not reasonable in those cemeteries having high interment rates, say exceeding 5 interments per day.

Of course, the best way to reduce costs is to find less expensive liners. The costs of liner contracts (including placement) varied in 1978 from $46 per unit to $107 per unit, with the national average at $80. One cemetery in FY 1977 had had a contract for concrete bell liners delivered—but not placed—for $22 per unit. All cemeteries had twelve month contracts except one which was for three months. The type of liners used varied to some extent, with the type bringing the lowest cost

being the bell-type design, both in concrete and fiberglass. The bell-type design saves money in two ways: first, it is cast in one piece rather than two or more and, secondly, it is placed in one operation rather than two following the lowering of the casket.

Under conditions of unstable collapsing sands, bell liners are difficult to use. When inadvertent collapses occur after or during the placing of the casket a great deal of time-consuming hand labor is required before the bell can be set properly.

The principal advantages to the use of durable liners are in the resultant reduction of sinkage problems and maintenance costs, better appearance of the cemetery, and the increased safety in moving equipment over occupied graves.

Liners vary in design from one locality to the next. In order to meet the requirements of the Veterans Administration they must be able to withstand a 9,000 lb. axle load tested under simulated interment conditions and conform to the following dimensions (Ref. 3.7):

Type of Liner	**Minimum Interior Dimensions**	**Approximate Outside Dimensions**
Small	58″ ± 3″x20″ ± 2″x18″	63″x24″x22″
Standard	86″x30″x24″	89″x33″x28″
Oversize	90″x32″x26″	93″x35″x30″

3.4 Size and Depth of Gravesites

The fifty square foot gravesite (5′x10′) is the predominant size in 90 national cemeteries and the currently preferred standard. Some cemeteries have more than one standard size gravesite and all have the potential for odd-shaped and smaller sizes for cremains where a given gravesite is obstructed by a tree or rock, a curve in the road, a utility line and so forth. Four cemeteries have a uniform gravesite of twenty-four square feet (3′x8′) and there is one cemetery each having one of the follwing gravesite sizes: 4′x9′, 4.5′x9′, 4′x10′, 5′x8′, and 5′x12′ (Ref. 3.8).

In recent years the Department of Memorial Affairs has granted to certain cemeteries facing difficult excavation or groundwater problems permission to use a sixty square foot gravesite (6′x10′).

The normal depth for a first burial is seven feet in a 5′x10′ gravesite. This allows the second burial to occur directly on top of the first burial and still leave sufficient soil cover when liners are used. The hole that is dug, usually using a backhoe, is 36″ ± wide, 98″ ± long, and 7′-0″ deep. In a 5′x10′ gravesite, if the interment is a veteran the upper zone can be used by up to two eligible dependents such as a deceased child and wife. Had the first interment been the wife of a veteran, she can be placed to one side at the 7 ft. level, leaving room for up to three additional interments. This type of flexibility, even though it sometimes means encroaching slightly on a neighboring gravesite, is not possible with narrower gravesites.

The standard procedure for the inground interment of cremains is to place the urn or container approximately two feet deep in a gravesite one half the normal size for that particular cemetery, i.e. 5′x5′, 6′x5′, 3′x4′, etc. These half size gravesites usually occur at the end of rows near curbs, on steep banks or isolated in obstructed gravesites. The number of cremains in relation to the total burial rate at 22 sample cemeteries varied in FY 1978, as shown in Table 3-1, from 0% to 23%, averaging 4.6%. In those sections of the country where the percentage of cremains is currently relatively high the cremation rate is expected to climb. At the one cemetery where no cremains were interred, the cremation rate is likely to be non-existent for some time in the future. It was the general concensus among national cemetery directors whose cemeteries were visited by the

study team that the number of cremations will be on the increase in almost every part of the country. A few national cemeteries with high rates of cremains interment have selected a special section devoted exclusively to the inground interment of cremains.

TABLE 3-1

Cemetery	No. of Cremains/Total Burials	Rank
CA-2	23.2%	1
CA-1	18.4%	2
VA-2	10.2%	3
FL-1	9.6%	4
NM-1	6.8%	5
CA-3	6.4%	6
CO-1	6.1%	7
TX-3	3.4%	8
TX-1	3.3%	9
WI-1	2.9%	10
TN-5	2.4%	11
TX-2	2.2%	12
KS-1	1.7%	13
TN-3	1.4%	14
OR-3	1.0%	15
MO-1	0.9%	16
HI-1	0.7%	17
NY-1	0.6%	18
TN-1	0.2%	19
MN-1	0.2%	20
TN-4	0.2%	21
PR-1	No cremains recorded	22
	Average 4.6%	

Besides the normal interment of deceased servicemen and veterans in a single plot, there are special situations and former policies which affect the amount of land designated for a single individual who has served his country in times of war and insurrection. From 1890 to the present time deceased wives and widows have been eligible to be buried in national cemeteries. Since 1904 dependent children who die before reaching majority have been accorded the same benefit. While prior to 1962 each had his own gravesite, currently all members of the veteran family unit are interred in a single gravesite.

Sometimes a disaster occurs and a large number of soldiers lose not only their lives but their identity as well. The total number and names of the soldiers destroyed in the disaster is known but the individual corpses cannot be identified one from another. The remains are all placed in caskets and liners and buried together in what is known as a group burial. This large gravesite is then marked with a large monument on which are placed the names of the men who lost their lives in the disaster. Another situation which usually allots one-half a gravesite to a deceased serviceman or veteran is called a memorial. A memorial gravesite is for a person who dies but whose body can not be recovered, such as in drownings at sea; airplane crashes in unreachable locations; terrible fires where no remains can be found; and other situations of similar severity. Many national cemeteries have set aside a special section for memorials and the gravesite is marked "in the memory of" followed by the name of the deceased. A few large cemeteries have a "Court of Honor" for distinguished veterans who have earned high honors in the service of their country.

3.5 Methods of Handling Soil and Compaction

The phenomenon of severe grave sinkages arising from the collapse of wood caskets or liners under conditions where liners made of durable materials are not used (see Photo 3.1) is discussed in Chapter 8. Leaving aside such collapses, it is commonly accepted that the principal contributor to the settlement of gravesites is unsatisfactory backfilling techniques. Another operation that can affect the severity of the sinkage is improper shaping of the grave. The type of soil itself is a third factor. External forces, such as heavy rains, frost heaves, or the movement of heavy vehicles over the completed gravesites, can aggravate or expedite the soil settlement. Although most private cemeteries have sinkage problems, they are usually not as apparent as in the majority of national cemeteries, where the upright headstones frequently tilt and heave into unsightly disarray.

The normal procedure for opening graves in national cemeteries is excavation by a backhoe. Most cemetery directors answering the questionnaire sent to them for this study indicated that graves are dug mechnaically. Twelve cemeteries contract out grave digging and at least 7 are digging by hand (Ref. 3.8). The standard backhoe excavates a hole 36 ± inches wide, 96 ± inches long and five to seven feet deep. It is virtually impossible, even in ideal soil conditions, to create a grave with smooth, even vertical walls and a level floor. The walls are often undercut near the bottom of the grave by the teeth of the backhoe. Consequently, the 33"x89" liner is usually placed with irregular voids left under it and at its perimeter. Hand shaping of the sides and floor (often done in private cemeteries) was not observed by the study team to be a general practice in national cemeteries.

The soil excavated from the grave is used to backfill a nearby grave that has already received a liner and casket, but some soil is always left over. Excess excavated soil is usually disposed of in an undeveloped portion of the cemetery. Cemeteries without undeveloped areas will use what they can of the excess to fill sinkages but often sell the rest or pay for it to be hauled away.

The study team observed a number of different procedures for opening consecutive graves on a normal day. Although the procedures vary from one cemetery to another all were reasonably efficient and seemed the most effective for their local conditions. Cemeteries with 5'x10' gravesites usually dig graves in succession without skipping any. The 2 ft. ± wide wall of unexcavated soil left standing is usually stable enough to stand except in sandy cemeteries where sequential 7 ft. deep excavations always collapse. The usual remedy is to go to 6'x10'x5' deep gravesites. Cemeteries with 6'x10' gravesites, as a rule, excavate one-half of a gravesite and the near half of the next gravesite so that both adjacent half-graves are dug at the same time, as depicted in Figure 3.1. This leaves a 6 ft. wide space between adjacent excavations.

At one cemetery we observed a variation on the normal procedure for 5'x10' gravesites. When beginning a new row, gravesite No. 1 is excavated and all the excess soil is disposed of at a section of undeveloped cemetery land. Site No. 5 in the row is the next to be dug. Its excavated soil is used to backfill site No. 1. Site No. 3 follows with its soil used as backfill for site No. 5. After No. 3, No. 2 is dug and the excavation from No. 2 is used as backfill for No. 3. The procedure continues in the same fashion with No. 4 and then numbers 6, 10, 8, 7 and 9 to repeat the cycle. This process reduces cave-ins and provides for better maneuvering of equipment around the graves being dug.

Photo 3.1

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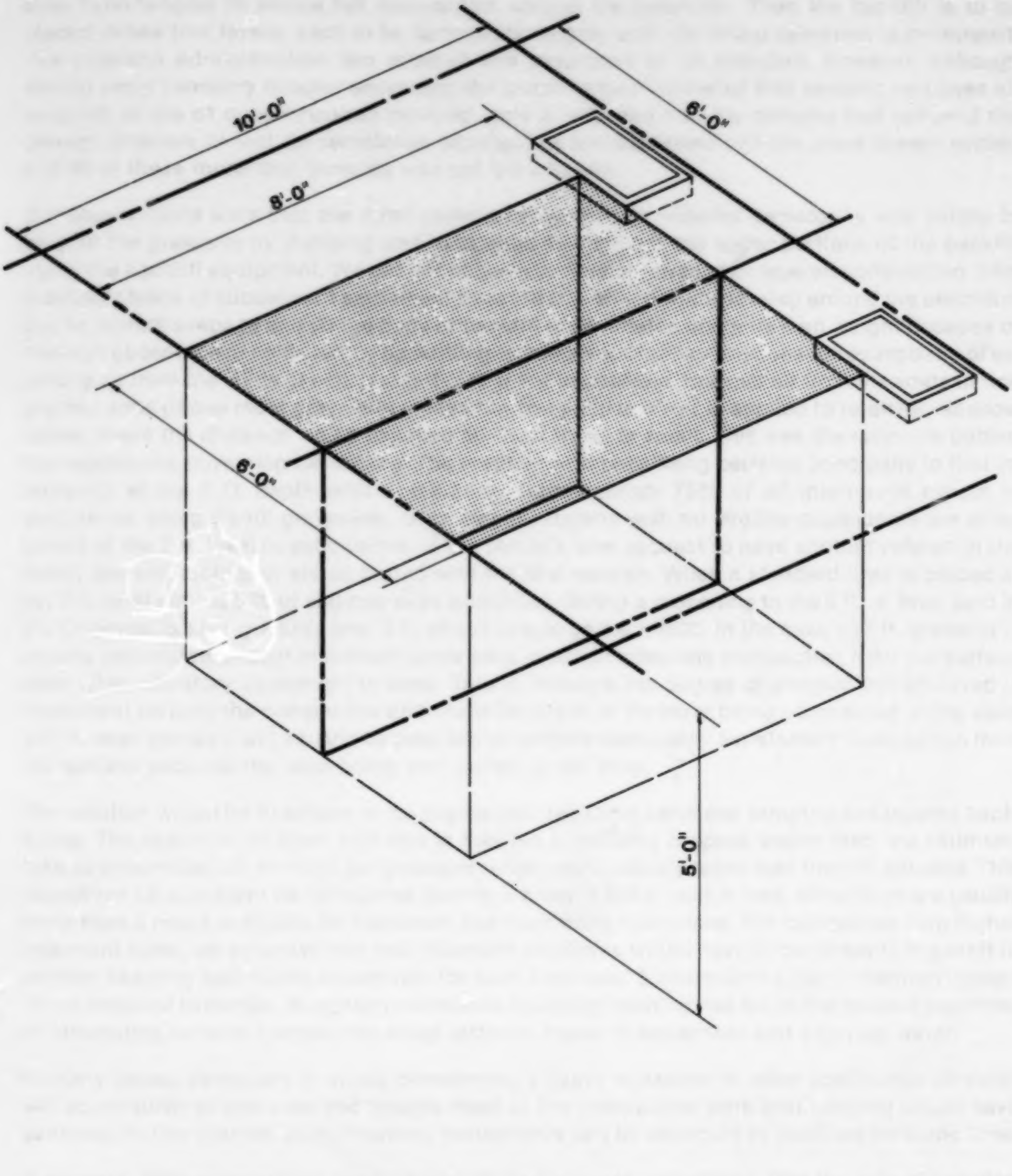

DOUBLE GRAVE EXCAVATION FOR INITIAL INTERMENTS, 6'x10' GRAVESITES **Figure 3.1**

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Before the Veterans Administration took over the operation of national cemeteries in 1973 from the Department of the Army, there had been established regulations for the proper backfilling procedure (Ref. 3.9). They state that the casket or liner is to be backfilled carefully on all four sides and then hand-tamped to assure full compaction around the perimeter. Then the backfill is to be placed in one foot layers, each to be tamped thoroughly until the filling operation is completed. The Veterans Administration has retained this regulation as its standard. However, although almost every cemetery director answering the questionnaire indicated that tamping had been attempted, of the 61 questionnaires returned, only 2 indicated that the tamping had removed the sinkage problem. In fact, 58 cemeteries reported the soil backfilled into the grave always settled and 55 of these found that tamping was not the solution.

Our observations were that the most common procedure in national cemeteries was simply to backfill the gravesite by dumping and to attempt to compact the upper portions of the backfill using the backfill equipment. We did not observe perimeter tamping or layered compaction. This inevitably leads to subsequent settlement because (1) unfilled voids develop around the perimeter due to rainfall seepage and (2) the body of backfill consolidates under its own weight because of the high pecentage of voids left by backfilling techniques. Compaction consists essentially of expelling air from the voids of soil. It is difficult, if not impossible, to expel air from the voids of fine grained soils (those most prevalent) unless the compactive effort is applied to relatively shallow layers where the distance which expelled air must travel is small. This was the rationale behind the regulations governing backfilling. The problem with backfilling pertains principally to first interments at the 7 ft. depth which constitute approximately 75% of all interments except in cemeteries using 6'x10' gravesites. Even single veterans with no eligible dependents are often buried at the 7 ft. level in anticipation of the family's later request to have another veteran in the family (parent, brother or sister) buried with the first veteran. When a standard liner is placed at the 7 ft. level almost 5 ft. of soil has to be backfilled. During a reopening to the 5 ft. ± level (and in 6'x10' gravesites) only a little over 2 ft. of soil has to be backfilled. In the case of 7 ft. graves it is usually impossible except in certain sandy soils to attain adequate compaction from the surface even when vibratory equipment is used. This is because the degree of compaction achieved is dependent on both the compactive effort and the depth of the layer being compacted. In the case of 5 ft. deep graves it will usually be possible to achieve reasonably satisfactory compaction from the surface because the layer being compacted is not deep.

The solution would be to adhere to the regulations requiring perimeter tamping and layered backfilling. The essential problem with this is that the backfilling process would then, we estimate, take approximately 25 minutes per gravesite when now it usually takes less than 10 minutes. This should not be a problem for cemeteries burying 5 a day (1,200 a year) or less, since there are usually more than 3 hours available for interment and backfilling operations. For cemeteries with higher interment rates, we estimate that one interment employee would have to be added to the staff to perform tamping operations exclusively for each additional 5 interments a day or fraction thereof it was required to handle. Budgetary resistance to adding staffing has led to the present practices of attempting surface compaction using different types of equipment and applying water.

In many cases, especially in sandy cemeteries, a heavy rainstorm or other application of water will accomplish at less cost and trouble most of the compactive work that tamping would have achieved. In fine grained soils, however, settlements can be expected to continue for some time.

It appears, from observations made during visits to private cemeteries, that the type of tamping equipment used has a great effect on the success or failure of solving the soil settlement problem. A few private cemeteries are still using hand tamping methods on backfill placed in layers with uniformly good results. Most cemeteries that felt they had solved the sinkage problem are using a vibrating mechanical tamper that is applied to the fresh backfill within forty-eight hours of the closing of the grave. Some national cemeteries are also employing mechanical tampers of varying design and with varying degrees of success. (See Photo 3.2)

There appears to be a universal abhorrence to water reaching the interred remains in a grave. Everything is done to assure the public that the casket in the ground is going to remain dry. Even concrete grave liners are provided with drain holes so that water that may seep in through the top lid theoretically will find its way out through the drain holes in the bottom. Private cemeteries are continually capitalizing on the public distaste for water in a grave by marketing above-ground burials and expensive sealed vaults if inground interments are desired. Consequently, the process of applying water to backfill to insure a uniform and immediate compaction of the soil is not widely used—at least cemeterians, both public and private, are not quick to admit that water is used to settle the backfill. When confronted with the question private cemetery directors usually replied that water might be used in extreme situations but never as a general rule. However, the observations made during visits to private cemeteries indicate that the practice is more widely used than admitted, and this may be why private cemeteries appear to have fewer settlement problems than national cemeteries, in general. The answers to this question (on the questionnaire sent to National Cemeteries for this study) showed that only 8 of the 61 cemeteries responding use irrigation in backfilling graves, but those that do reported a fairly high amount of success in solving their sinkage problem.

It is a well known phenomenon that draining water will consolidate loose soil. It is very effective in sandy soils where air is easily expelled through the open pore system. It is relatively effective in most other loamy soils, even if clayey, that break-up into friable aggregates of soil particles when excavated. Water can be applied with watering trucks, and temporary or permanent irrigation systems. However, there have been public objections to this practice. The objections are emotional ones inasmuch as the next heavy rain storm would have achieved the same result. Probably the best procedure to follow in applying this method, were it to be used when there is an irrigation system installed, is to apply water to new interments areas only in the hours after closing and prior to opening. This "assistance to nature" would permit an orderly scheduling for dressing up the new grave areas.

3.6 Depth of Soil Cover

Of the twenty-two national cemeteries studied in detail, the reported soil cover depth over liners or caskets ranged from 12 inches minimum to 60 inches maximum, with average depth of 26.5 inches. The private cemeteries visited reported a range of from 15 inches minimum to 36 inches maximum with an average of 21.75 inches. The depth of soil cover is important for two reasons: (1) when there is insufficient soil depth between the ground surface and an impervious surface buried beneath it, lawns tend to dry out and sod cannot be maintained and (2) when the amount of soil cover is insufficient, damage by equipment is more probable.

Several sources (Ref. 3.10) state that over an artificial or impervious subbase lawns can be maintained with an appropriate soil mix at a minimum depth of six (6) inches. However, this special soil mix must be placed over a layer which will provide thorough and uniform drainage at all times. It also implies that the soil mix will be kept sufficiently moist by natural or artifical irrigation. In ordinary soil conditions, drainage below the topmost six inches that supports root growth is provided by storage in the voids of the soil below. At 35% voids and 50% air clogging, typical values for average loamy soils, a depth of 12 inches of soil underlying the 6 inch growth zone would provide 2 inches of pore storage space. This is sufficient to handle very heavy storms and prevent

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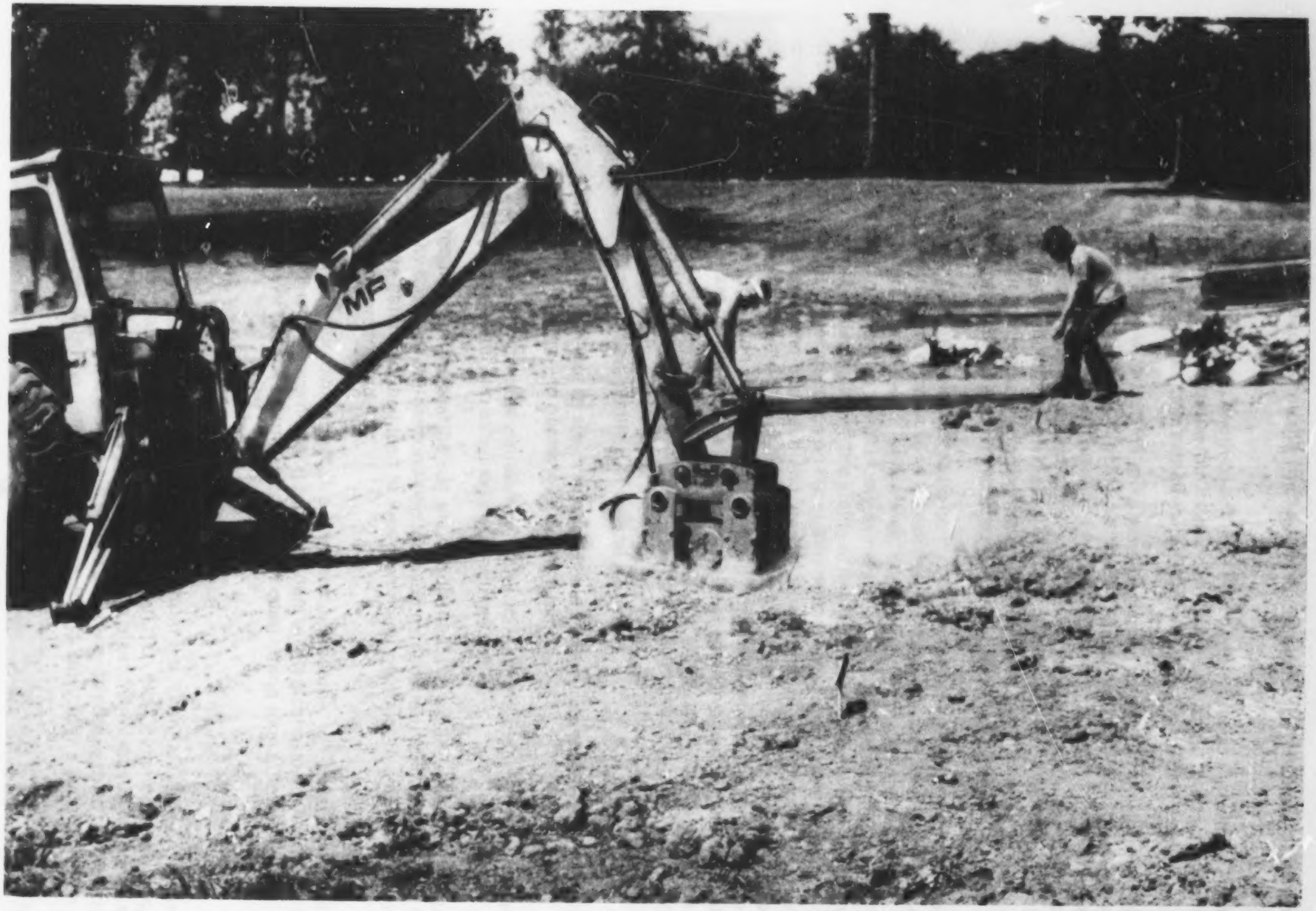

Photo 3.2

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oversaturation of the grass roots. Eventually the trapped water either drains laterally or transpires through the roots.

As a general rule, then, the minimum depth of soil to insure healthy uniform growth is eighteen (18) inches. Some states have laws for the minimum cover over an inground interment. Eighteen inches is incidentally the most common minimum cover required by those state laws.

When two standard size liners with flat lids are placed beginning at the 7 ft. level, the depth of soil cover over the topmost liner is approximately 24" to 28". This is sufficient to spread a 4,500 lb. wheel load (half the specified design axle load) fairly uniformly over the 30 inch span of the liner top and to nullify impact loadings. Calculations indicate that under such typical conditions the 2 inch minimum thickness specified for concrete lids will require reinforcing to resist the specified wheel load without cracking. In general, precast concrete box liners and bell liners appear to be built throughout the country with as little material as permitted by specification.

In some cases it would be desirable, because hard rock or another difficult soil problem is encountered, to reduce the depth of cover to 18 inches or even 12 inches. Eighteen inches of cover will probably not affect grass quality; 12 inches may, depending on the soil and climate. If it is desired to use 12 inches to 15 inches cover in any cemetery, a test panel should be set up at that cemetery to observe lawn problems, if any. The ability of liners to resist damage from wheel loads at cover depths of 12 to 18 inches depends on the quality of liner construction and amount of reinforcing (in concrete liners) on the one hand and, on the other hand, the ability of soil to spread loads applied at the ground surface. The ability of unprotected wooden or metal caskets to resist wheel damage depends greatly on their thickness, quality of fasteners and the shape of the lid; curved or arched shapes are considerably stronger than flat shapes. In all such cases of shallow cover, it is preferable to run simulated tests in place using the same backfilling methods as are usually used in order to test the combined system of structure and soil. The specified 9,000 lb. axle load can then be applied in accordance with the specified functional test (Ref. 3.7). We believe the specification should be modified in several respects:

(1) To require the liner to resist a load 20% ± higher than the 9,000 lb. axle load without cracking—to permit some safety factor.

(2) To permit an individual cemetery director to require a higher test load if he is using equipment with axle loads exceeding 9,000 lb.

(3) To require that the test be run under conditions of saturated backfill. This is usually the most critical condition for loading concentration because when fine soils are saturated they tend to lose their shearing strength and therefore their ability to spread load.

Naturally, the cemetery director cannot require minimum standards for privately furnished caskets so that, if he is not using government furnished liners and typical caskets fail at shallow depths of cover, he will have to seek alternative means of overcoming foundation problems.

3.7 Types of Markers

There are four basic types of grave markers used at present in the National Cemetery System. (Photos 3.3 through 3.6 show examples of each type of marker). The most common is the upright marble type used in about 80% of all national cemeteries. The other three types of markers used are all the flat type, namely granite and marble cut stones and a bronze plaque fixed to a concrete base. Markers are inscribed with the veteran's name, rank and service; the wars in which he fought; and the dates of his birth and death. On the reverse side of upright monuments are placed the names of dependents whose remains are buried in the same gravesite. Flat markers have names added to their faces. The names are not added to the existing marker; rather, the whole marker is replaced whether upright or flat, with the additional names added in the appropriate place.

Although upright markers are the standard in 80% of national cemeteries, the trend is to change to flat markers which are less expensive and somewhat easier to maintain. However, very few cemeteries that have always used upright may change to flat markers. In a few existing cemeteries with large areas still undeveloped it may still be possible to make the switch in reasonable fashion. Keeping upright markers in proper alignment and grade and keeping them clean was observed to be a difficult task. Of the 22 cemeteries studied in detail in FY 1978, 14 were using all upright markers, and 3 were using a majority of upright markers while one had an equal number of upright and flat.

Four of the 22 sample cemeteries investigated were using flat markers in FY 1978. Two averaged 9.0 acres maintained per maintenance employee—well above the system average of 6.8—and two averaged 3.8 acres maintained per maintenance employee—well below the average. Therefore, nothing conclusive can be determined from these data about the impact of the use of flat markers on routine lawn maintenance, excluding realignment of headstones and other sinkage repair work. The same results were found in the private cemeteries visited, where most directors indicated that it cost just as much to maintain an upright monument as it did for a flat one. One major reason for this is that the cost of trimming around the headstone is no more work than trimming a flush marker.

The data in FY 1978 concerning the work of raising and realigning headstones is equally inconclusive. Productivity for this task in the four cemeteries using flat markers varied from no realignment work at one cemetery to 7.5 headstone units per man hour, averaging 4.6 units per man hour. Productivity for the other cemeteries using upright markers varied from 1.7 to 11.7 headstone units per man hour, averaging 4.7 units per man hour.

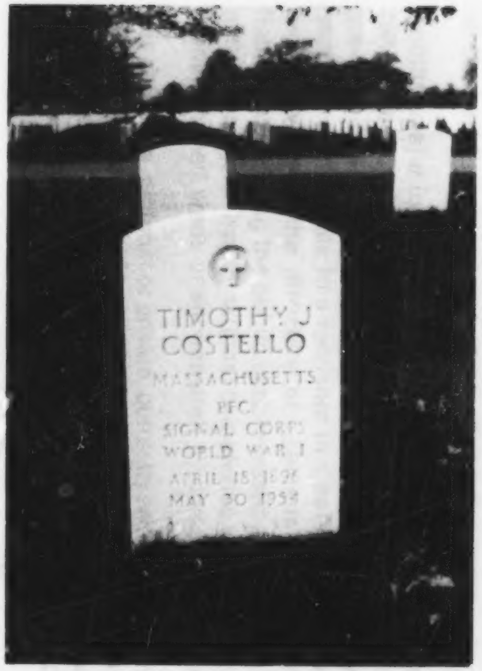

Photo 3.3

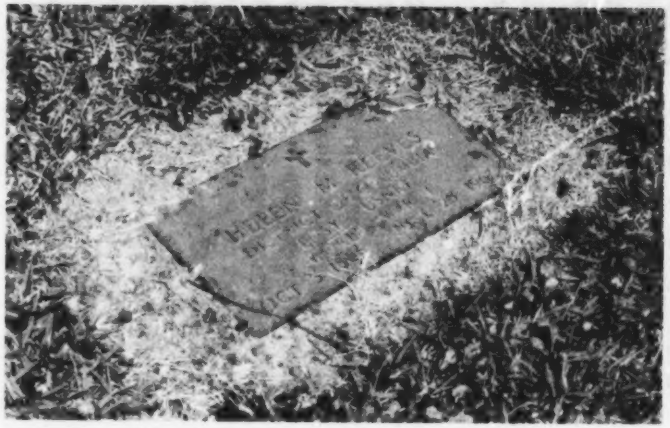

Photo 3.4

Photo 3.5

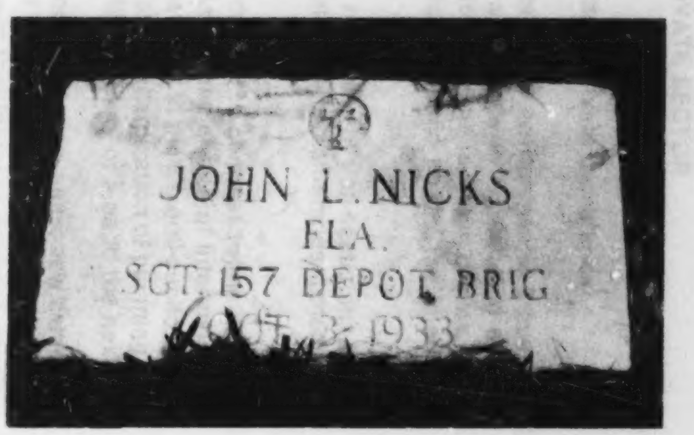

Photo 3.6

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4 ALTERNATIVE INTERMENT METHODS IN THE PRIVATE SECTOR

4.1 Factors Influencing the Choice of Interment Methods in Private Cemeteries

In order to observe interment methods in the private sector under environmental influences similar to those experienced in national cemeteries, visits were made to cooperating private cemeteries in close proximity to each national cemetery visited. As the location, degree of urbanization and socio-economic characteristics of the population varied so did the interment methods and procedures.

Our sample of 22 private cemeteries included: 1 military; 7 religious; 13 non-sectarian; and 1 municipal cemetery. Except for 12 of the non-sectarian cemeteries, all the cemeteries visited were operated on a non-profit basis.

Whether organized to be non-profit or profit-making each cemetery, in contrast to the national cemeteries, based its operations, planning for future development and choice of interment services offered on the local market for the sale of products and services to the general public. Since no impartial benefits need to be dispensed in the private sector, standardization of planning and development or operational methods are not required from one cemetery or area to the next.

In highly urbanized areas where the cost and availability of land are at a premium, new cemetery development is usually directed towards extending the life of the existing cemetery rather than toward the addition of cemetery acreage. Methods of interment that increase gavesite density such as multiple depth interments in preplaced lawn crypts, garden crypts, wall crypts, mausoleums and columbaria are used. In addition to increasing gravesite density compared to usual inground burials, all of these methods minimize some of the difficulties in dealing with excessive slopes; preservation of vegetation; poor digging conditions; climatic problems of ice and snow; and ground water or a high water table. The result is that the private sector is free to respond to environmental difficulties with whatever alternative methods the public wants or will buy. The necessity to market services also results in the construction of facilities not found in national cemeteries, such as casket, liner and headstone showrooms and retail shops. Special attractions such as exotic gardens or prominently displayed works of art are used to create focal points of interest that add ambience and give the cemetery a special character, making it desirable to visit. For instance, Photo 4.1 illustrates a statue used as a focal point.

Appearances vary considerably among private cemeteries and are generally quite different from that of the National Cemetery System. Buildings, memorial structures and gravesite areas are all designed to appeal to individual and diverse tastes.

Another major influence tending to force variations in planning, development and operations not felt in the NCS is the gravesite size and location being determined by the public on the basis of pre-need sales as well as time-of-need sales. Essentially every inground interment in the private sector is comparable to a reopener in a national cemetery. The special care for completed adjacent gravesites, the difficulty of gravesite preparation in relatively confined areas and the liabilities of having the public concentrated around an open grave become more critical planning and cost factors than in national cemeteries which can schedule sequential gravesite locations in predetermined areas unencumbered by completed graves in three interments out of four.

Any cemetery, national or private, currently receives remains in only two forms: full body or casketed remains and cremations or cremains. The latter are received in an urn or other container and are described as non-casketed. The disposition of these remains in the cemetery is either inground or above ground. Table 4-1 lists the various interment methods observed in private cemeteries.

TABLE 4-1

INTERMENT METHODS OBSERVED IN PRIVATE CEMETERIES

1. Inground, casketed:
    a) direct burial in the bare earth
    b) interred in a concrete box liner
    c) interred in a concrete bell liner
    d) interred in a concrete vault with a lid
    e) interred in a concrete bell vault
    f) interred in a preplaced concrete lawn crypt
2. Inground, non-casketed:
    a) directly in the bare earth
3. Above-ground, casketed:
    a) entombment in a family mausoleum
    b) entombment in a public mausoleum
    c) entombment in a garden crypt
    d) entombment in a wall crypt
    e) entombment in a sarcophagus
4. Above-ground, non-casketed:
    a) entombment in add-on wall niches
    b) entombment in a columbarium structure

The predominant method observed in all cemeteries was the interment of casketed remains inground.

4.2 Variations in Inground Casketed Interments

Digging the graves was observed being done most frequently with a backhoe, the day before or the morning of the interment. In cemeteries where the density and size of grave markers was such that even a small backhoe could not be used, then the grave was dug manually. In one such cemetery with flat terrain and sandy soils we were advised that two men could open a single grave 3′-0″ wide x 8′-0″ long x 5′-0″ deep with hand shovels in one hour.

The depth of excavation varied depending on the number of interments intended. The difficulty of digging in hard clay, rock, or unstable soils such as sand, or a high water table were the principal problems encountered. These problems were overcome by using specially designed ground breaking equipment, shoring, or, in the case of a high water table or excessive ground water, the use of dewatering equipment. The gravesite excavations varied from 2′-10″ wide to 3′-6″ wide by 8′-0″ ± long. The predominant size of the grave opening observed was 2′-10″ wide by 8′-0″ long. The most common gravesite size was 3′-0″x9′-6″ ±. In every cemetery visited the problems attendant to the efficient completion of interment were principally the timing of funeral arrivals and the distance between the locations of the committal service and burial site. The actual lowering of the casket was accomplished in two ways: by hand using 4 to 6 persons or by a commercially available mechanical lowering device. The latter was used predominantly. In one cemetery a front

Photo 4.1

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end loader was used, whenever possible, to lower the casket into the grave after it had been placed in a concrete vault or liner. It was done after the funeral party had left the gravesite.

Backfilling the gravesite was done in several ways depending on the "set-up" for interment (the tent, chairs, flowers, etc. at the gravesite) and the gravesite location. In some cases the interment set-up was such that the soil for backfilling could be left immediately adjacent to the gravesite in a neat pile and covered with artificial turf or in a wooden box. Photo 4.2 illustrates such a situation. Backfilling was then accomplished by manually shovelling or using a front end loader to push the soil into the grave. In other cases soil was kept away from the gravesite but nearby in small dumpsters. These dumpsters could later be moved to the gravesite at the proper time for the soil to be replaced in the grave. The aspect of the backfilling procedure most critical to the later appearance and maintenance of the grave is the tamping procedure followed, if any. Every cemeterian stated that every grave was tamped. The methods varied with each cemetery as soil conditions changed. In granular soils water was used as well as mechanical and hand tamping. When tamping loam or clay, mechanical methods were most frequently observed. Settling with water was reportedly done with the irrigation system. One cemetery with sandy soil, however, reported the effective use of puddling new graves with 500 gallons of water placed directly on the grave with a 2 inch hose. The results can be seen in Photo 4.3. Mechanical tamping was observed being done under varied soil conditions with hand-operated or backhoe-mounted vibrating head tampers applied at the ground surface. Tamping was sometimes done manually with poles between the sides of grave liners or vaults and the side walls of the excavation where soil usually is difficult to place and compact because of the close fit.

Finishing the grave in the great majority of cases involved the placing or replacing of sod. In a few cases the gravesite was covered with a full-size stone cover which also served as a marker.

Following sodding, the grave marker was installed. The grave marker provides the greatest opportunity for individualization. Upright markers requiring a large foundation necessitated longer gravesites—9'-6" to 10'-0". The construction of the foundation varied according to the weight and size of the grave marker, but was generally poured concrete. In more densely planned smaller areas with narrow gravesites, flat markers were used. They were placed either without a foundation or on a 4 inch thick concrete pad directly on the ground. Because these markers are easily moved when correcting sinkages or reopening the grave they were frequently placed over the area of interment, thereby permitting shorter gravesites. Most were placed at the head but some were placed at the foot or the middle of the grave, depending on the desired overall appearance of each gravesite area.

A variant which very much affects the cemetery operation is the use of a durable graveliner. Sinkages, which are very unsightly and a liability to any cemetery, are minimized when caskets are placed in durable grave liners. The liners observed were all prefabricated. Some were completely assembled, others were assembled at the gravesite. Photo 4.4 illustrates a segmental type liner. All those observed were made of concrete and were not considered water-tight; in fact, they were formed with drainage holes.

Vaults which can look very similar to a grave liner accomplish the same purpose but are sold on the basis of being water-tight. Both the liner and the vault are usually placed in the grave by their manufacturer. However, sometimes, at the preference of the cemetery or the family, the liner or vault was supported over the gravesite during the committal service to be later interred by cemetery personnel after the casket was placed in it. The only reason for doing this, other than family preference in wanting to see the actual liner used, is the advantage to the cemetery in reduced cost because they, instead of the liner manufacturer, provide the placing labor.

The need to provide inground burial sites under difficult climatic and soils conditions, plus continually mounting economic pressure to increase gravesite densities, has led to the development of lawn crypts. A typical double depth unit installation is illustrated in Fig. 5.6. The public acceptance of this interment method has been very good. There were several cemetery owners who expressed concern because of the large up-front capital expense and the pressure to sell these gravesites on a pre-need basis in order to minimize financing costs. Lawn crypts are more economical when constructed for multiple interments; therefore this method was more frequently used in heavy population centers and in areas where there was no public resistance to interments one over the other. Although double depth lawn crypts were the most commonly observed, one cemetery visited used lawn crypts capable of accepting interments five deep. We were advised at this cemetery that 10 and 12 deep units are in use in other cemeteries. Under circumstances of crypts 5 or more deep, special agreements were made with the family of the deceased whereby they agreed to waive the possibility of disinterment in the future for any reason. These very deep crypts, which are very economical, were also used to inter in cases of financial hardship. Marking this type of grave is done by listing all the interments on a common marker placed over the crypt.

4.3 Inground Non-Casketed Interments

All cemeteries offered small gravesite sizes for cremated remains. When questioned about the frequency of requests for such gravesites, cemeterians generally indicated them to be 10 percent or less of total interments. The most influential factors affecting the number of cremains were the existence of a crematorium at or in close proximity to the cemetery and the question of whether cremation was customary to certain ethnic or religious groups represented in the population served by that cemetery.

The procedure for making a non-casketed interment was accomplished by manually digging a 12 inch square grave 24 to 36 inches deep. After the interment of the container is made, backfilling is again done manually and the gravesite is resodded and marked. In one cemetery a low stone garden wall was built around an area of approximately one-quarter acre in which a central thematic piece of sculpture was placed. Inground gravesites one foot square in size were sold in this area with a small bronze marker over each site.

4.4 Above-Ground Casketed Interments

The variations observed for entombing casketed remains above ground were primarily differentiated by cost. Mausoleums for individuals or families have always been and still are associated with wealth and social stature; therefore, great sums of money have been spent building very beautiful structures of stone that give every appearance of lasting for immeasurable periods of time. These structures are to be seen in almost every private sector cemetery of any size anywhere in the country, but today they are becoming too costly even for the private sector.

Recently, however, the need to market higher density above-ground gravesites and the technological advances in prefabricating relatively inexpensive concrete structures has led to the development of the garden crypt. Usually it is a large number of crypts constructed similar to those found in mausoleums except that the structure containing the crypts is not an enclosed building as in the case of the mausoluem but stands in a garden setting with the crypt faces part of the exterior walls.

Once the concept of the garden crypt was accepted, and it apparently has been accepted well by the general public, the concept of placing similar crypts in outside building walls and garden re-

Photo 4.2

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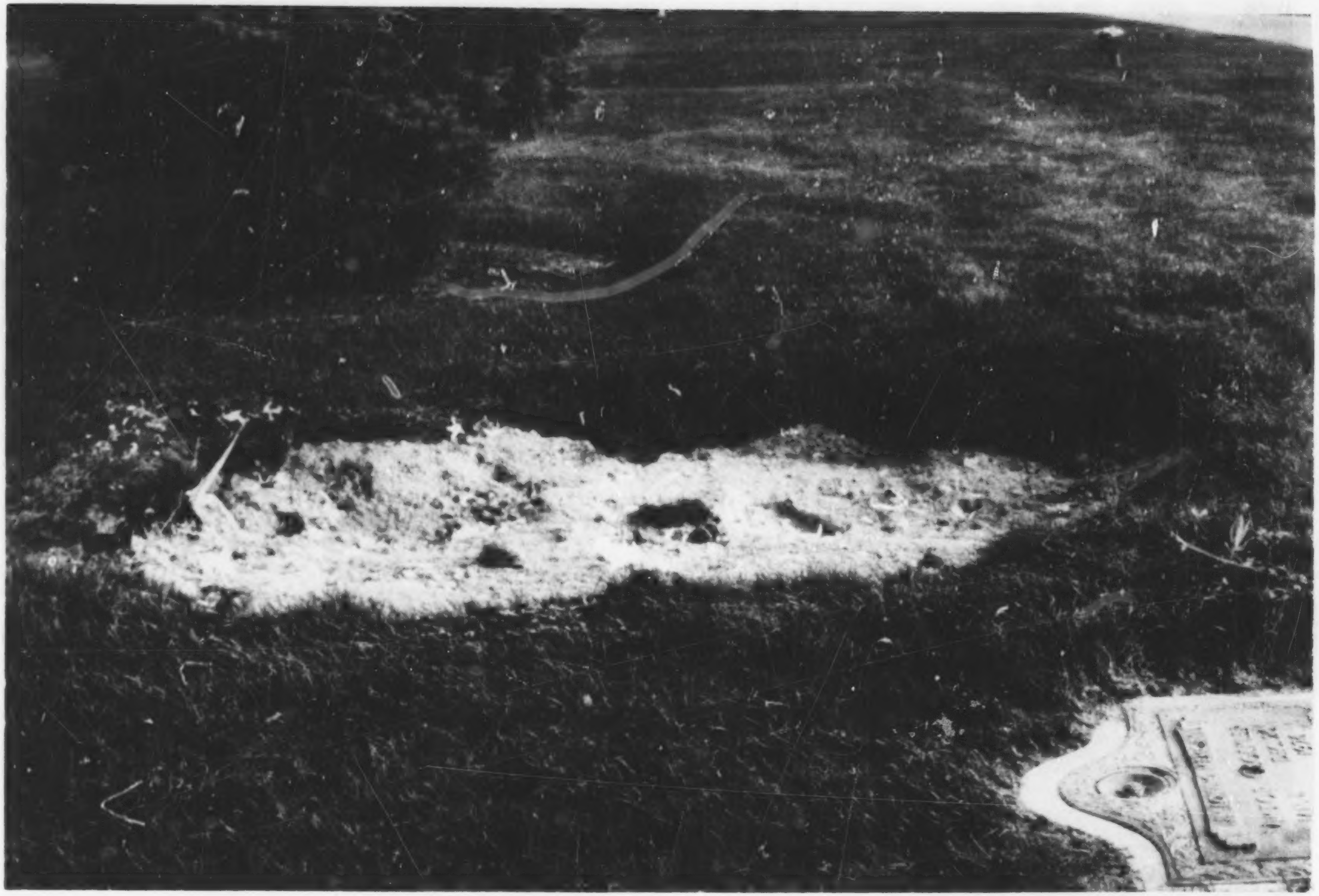

Photo 4.3

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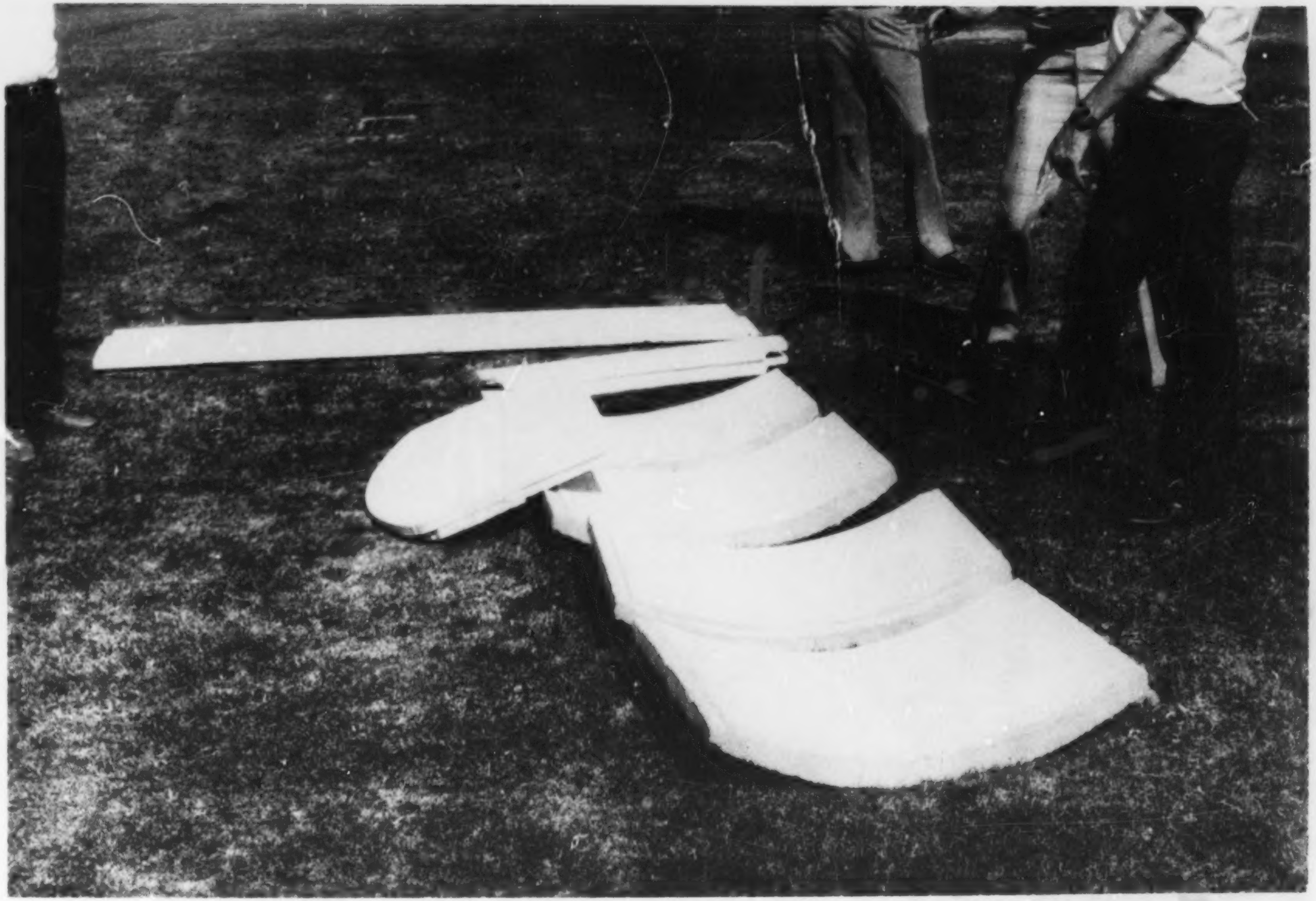

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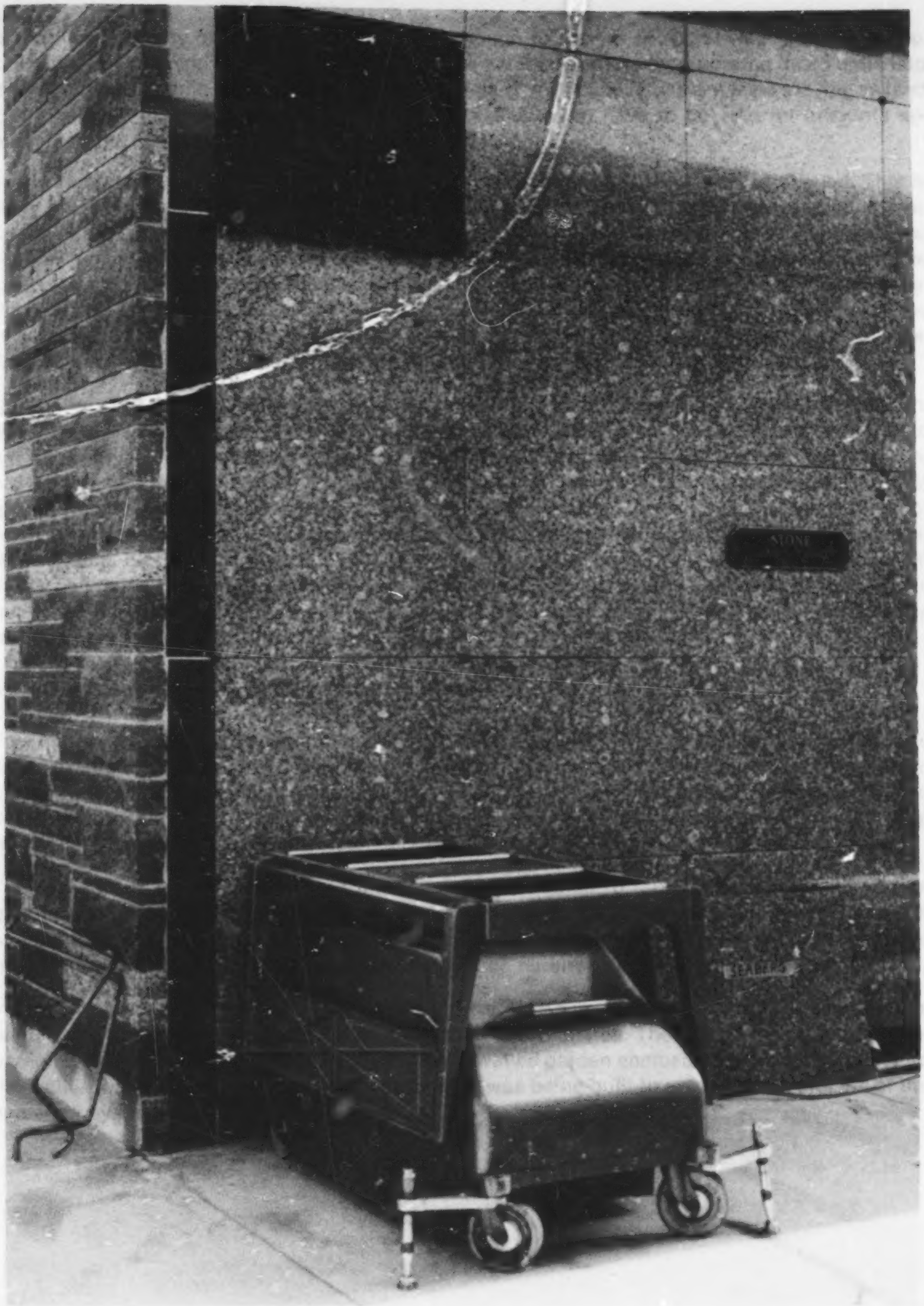

Photo 4.5

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taining walls or any other structure with bulk enough to receive a casket was found to be acceptable. Consequently, wherever possible private cemeteries have incorporated these units into their future development plans. The percentage of garden crypt development is increasing as land costs become high enough to cause inground gravesites to have to be sold for amounts approaching the cost of garden crypts.

The entombment procedure takes place in three stages. First the crypt front is opened. This is done manually by at least two men with hand tools and takes 30 minutes or less, depending on the crypt's location in the structure. Then the open crypt front is draped with a curtain in preparation for the casket. After the service, which may be held at the crypt or in a remote location, the casket is slid in manually or with special lifting or lowering equipment designed for the purpose. Photo 4.5 illustrates a garden crypt prepared for an entombment. The lifting device is in the foreground. This done, the crypt front is replaced and sealed and the entombment is complete. The replacement and sealing of the front consume very little more time than the opening.

Garden crypts are built in structures housing single or double depth crypts 4 to 7 levels high. Many are constructed with one or two levels below grade. These below grade units are referred to as "abbey crypts". The end walls of garden crypt structures if not used for columbarium niches or a thematic feature may contain "couch crypts". Couch crypts are crypts into which access is gained from the side instead of the end. Interment and grave marking procedures are identical for couch or standard garden crypts; however, the abbey crypt requires special lowering devices and the marking of the grave must be done on the standard crypt front immediately above it. Therefore, these crypts are usually sold together for multiple interments normally within the same family. Marking the gravesite is done by inscribing the front in place or fastening a metal plaque to it with the proper inscription.

4.5 Above-Ground, Non-Casketed Interments

This method of interment was most frequently seen used in conjunction with other methods. The volume of space required for cremated remains is small enough to allow columbarium niches to be constructed as part of other structures. The cost of gravesite construction is therefore offset to some extent. This offers the cemetery the option of increasing its margin of profit or of reducing the gravesite cost to the purchaser.

The procedures followed in making interments are identical to those used for mausoleum or garden crypt interments except that one man can normally do the job of removing the cover, placing the urn in the niche and replacing the cover. In cases where one outer cover is used over four or more niches, then two or more men would be required because of the weights involved.

In one cemetery, in an area where the demand for cremains interment is high, a large columbarium was being constructed with approximately 5,000 niches. The structure was an outdoor garden type construction consisting of a series of walled garden enclosures with niches built into the walls. This was the only one of its type seen. It was being built to extend the useful life of the cemetery by increasing gravesite density.

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5. PROTOTYPES OF INTERMENT METHODS JUDGED APPROPRIATE FOR NATIONAL CEMETERIES

5.1 Criteria for Appropriateness

All of the alternative interment methods used in the private sector have been evaluated at some time in one form or another by the Department of Memorial Affairs and Office of Construction of the Veterans Administration for the six years since it has assumed control of the National Cemetery System. Most alternatives have been rejected because they were too expensive or were judged inappropriate. That is the essence of this study: to determine the cost effectiveness of appropriate alternative interment methods.

The profile of the veteran family unit (the veteran and his eligible dependents) with respect to interments is approximately as follows:

- Less than 5% are single veterans and have no eligible dependents.
- More than 95% are married veterans. Eligible dependents are his or her spouse(s); children under 21 years; and physically dependent children.
- 26% of total interments are dependents of veterans interred usually, but not necessarily, in the same national cemetery. Less than 4% of total gravesites contain 3 or more remains.

When is an interment method appropriate? The simplest answer is: when it permits a dignified yet economical interment for the veteran and his eligible dependents and results in a burial ground that confers honor on those interred.

One point of veiw that may more easily define the mission of the Veterans Administration is to suggest that it should provide benefits at least equal to those available to the veteran in the private sector. In detail this implies several tests:

Test	Description
(a)	Place to conduct a dignified committal service in quiet, unobstrusive surroundings.
(b)	Gravesites at least equal in size to those provided by the private sector and space for interring the entire family unit in a common gravesite as is customary in the private sector.
(c)	Suitable memorialization of all members of the family unit on markers, plaques, etc.
(d)	Cemetery development esthetically equal to that provided in the private sector.
(e)	Maintenance of the cemetery appearance to relatively high standards.

The Veterans Administration must strive to realize these goals within two important limitations:

(1) The interment methods and procedures used should be cost effective, and

(2) Interment benefits must be afforded to all veterans without discrimination.

5.2 Inground Interments — 5'x10' Gravesite

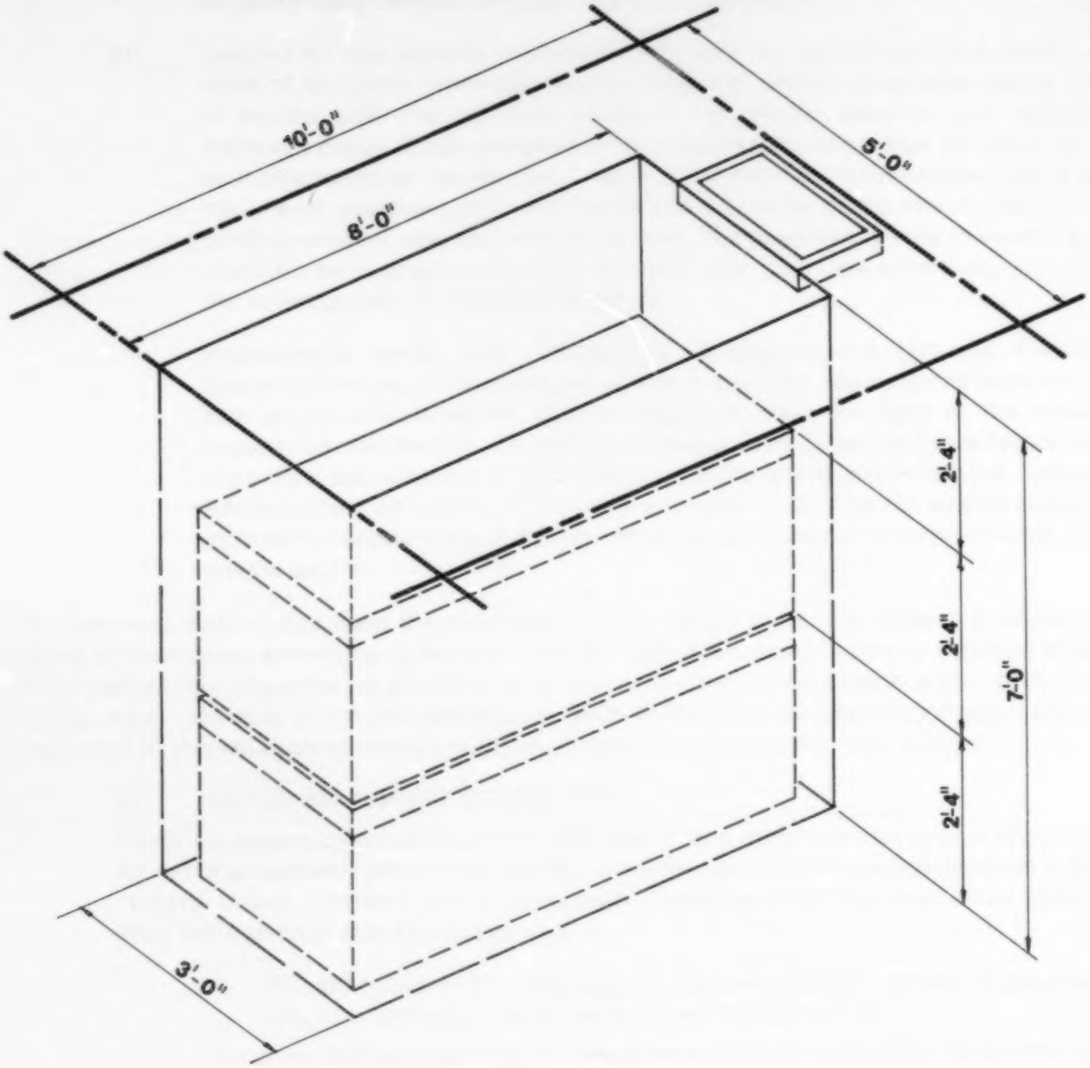
The standard interment method used by the National Cemetery System is a 5'x10'x7' deep inground gravesite depicted in Figure 5.1. The criteria for appropriateness as expressed in tests (a) through (e) are met in the following manner:

(a) In the usual case of a large active cemetery, interments occur sequentially in rows using heavy construction equipment for economy so that a relatively large area of cemetery is disturbed at any one time—rendering the burial site itself unsuitable for a dignified committal service. Typically a portable tent is erected at a suitable, remote location for the committal service and the family does not visit the disturbed burial ground on the day of interment unless it specifically requests permission to do so. In Calverton National Cemetery in New York, planned for the highest interment rate in the system, up to seven committal services can be occurring simultaneously, so that the cemetery plan incorporates a remote Committal Service Area where all services occur within permanent committal shelters located within a serene wooded environment remote from burial activities. In some national cemeteries with low interment rates it is possible to remove sod neatly and conduct dignified committal services at graveside—similar to common practice in many private cemeteries.

(b) The typical inground gravesite available in the private sector tends to be 3'x9.5'. It is typical in many cemeteries for the family to acquire a double plot suitable for interring six persons (2 plots x 3 deep). On the other hand, certain ethnic and religious groups prefer single layer burials in adjacent plots. Such a system, similar to the reservation method formerly used by the National Cemetery System, could become almost unmangeable and uneconomical of land use; except that the 6'x10' gravesite system does approach a single layer system. The National Cemetery System is dealing with a significantly smaller family group, 1.35 persons per gravesite, than the typical private sector situation and its standard 5'x10' gravesite represents an appropriate equivalent to the private sector. Typically the veteran and his spouse are buried one over the other in the middle of a 5'x10' plot. Only in the rare instance when a third or fourth dependent is interred are persons in the same family placed side by side in 3'x10' spaces—fully equivalent to the private sector. In such cases, the 6' ± width occupied by the two interments results in minor encroachment into adjacent gravesites but the space remaining in adjacent gravesites will still equal or exceed that typically available in the the private sector. In many ways, the 5'x10'x7' deep gravesite is a uniquely appropriate and efficient response to the need for providing the veteran and his dependents burial space in a common gravesite.

In most national cemeteries where it is comparatively economical to do so, the veteran and his dependents are furnished with liners to protect against casket collapses, similar to that which would be available to the veteran in the private sector. The liner is usually a precast concrete box with a lid, but in some cases is a fiberglass or concrete bell top liner that is lowered over the casket.

(c) Each veteran's gravesite is provided with a temporary marker at first, followed by a permanent vertical or flat headstone approximately two to three months later containing identifying information concerning the first person interred.



DOUBLE INTERMENT, 5'x10' GRAVESITE WITH FLAT TOP LINER OR VAULT **Figure 5.1**

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These headstones, which are later modified to include the names of others interred in the same grave, are necessarily uniform in design because of esthetic and economic considerations. Other than that, the memorialization is in all respects equal to that available in the private sector.

(d) Designs for new national cemeteries are being carried out using the design services of reputable landscape architectural and architectural/engineering firms in accord with the common theme of producing informal and attractive memorial parks. When completed these cemeteries should be the equal of the best private sector cemeteries. If there is any significant difference at all it is in the use of sculpture and other memorial elements in the private sector. The funding level for new national cemeteries has been barely able to meet the demand for new burial space and, therefore, has until now effectively precluded the development of memorial elements.

(e) Maintenance levels vary considerably throughout the National Cemetery System as they do throughout the private sector. Our observations were that the best of the private sector does a better job than the best of the national cemeteries, but that on the average national cemeteries compare favorably to the private sector. The policy to use durable liners within the National Cemetery System where economically feasible will tend to improve the overall picture of maintained appearance and bring the system into line with current trends in the private sector.

This interment method has been the most economical means at hand to date in providing the veteran with adequate benefits and, being in universal use, it inherently treats all veterans without discrimination. We observed no practices or procedures used in the private sector that, in our opinion, were adaptable to the peculiar requirements of the National Cemetery System and that would tend to increase the efficiency of its interment operations using this method.

(a) Appropriate Types of Durable Liners

There are many variations of durable liner design and materials that appear appropriate for national cemetery use so long as they meet the requirements of Specification X-1078c "Liners, Grave, Concrete and Thermoplastic/Thermosetting" for quality and strength. They fall basically into two categories:

(1) Precast concrete box with precast concrete flat lid; curved lid; segmental box. The curved lid variation is shown in Figure 5.2.

Our observations were that box liners were frequently partially filled with water even when drainage holes were present; seepage finds its way in and is trapped on the bottom. Another disadvantage is that the placing of the box and lid are usually contracted operations, between which cemetery forces lower the casket; this calls for considerable coordination in order to guarantee an efficient operation.

(2) Bell cover: precast concrete or fiberglass. See Figure 5.3.

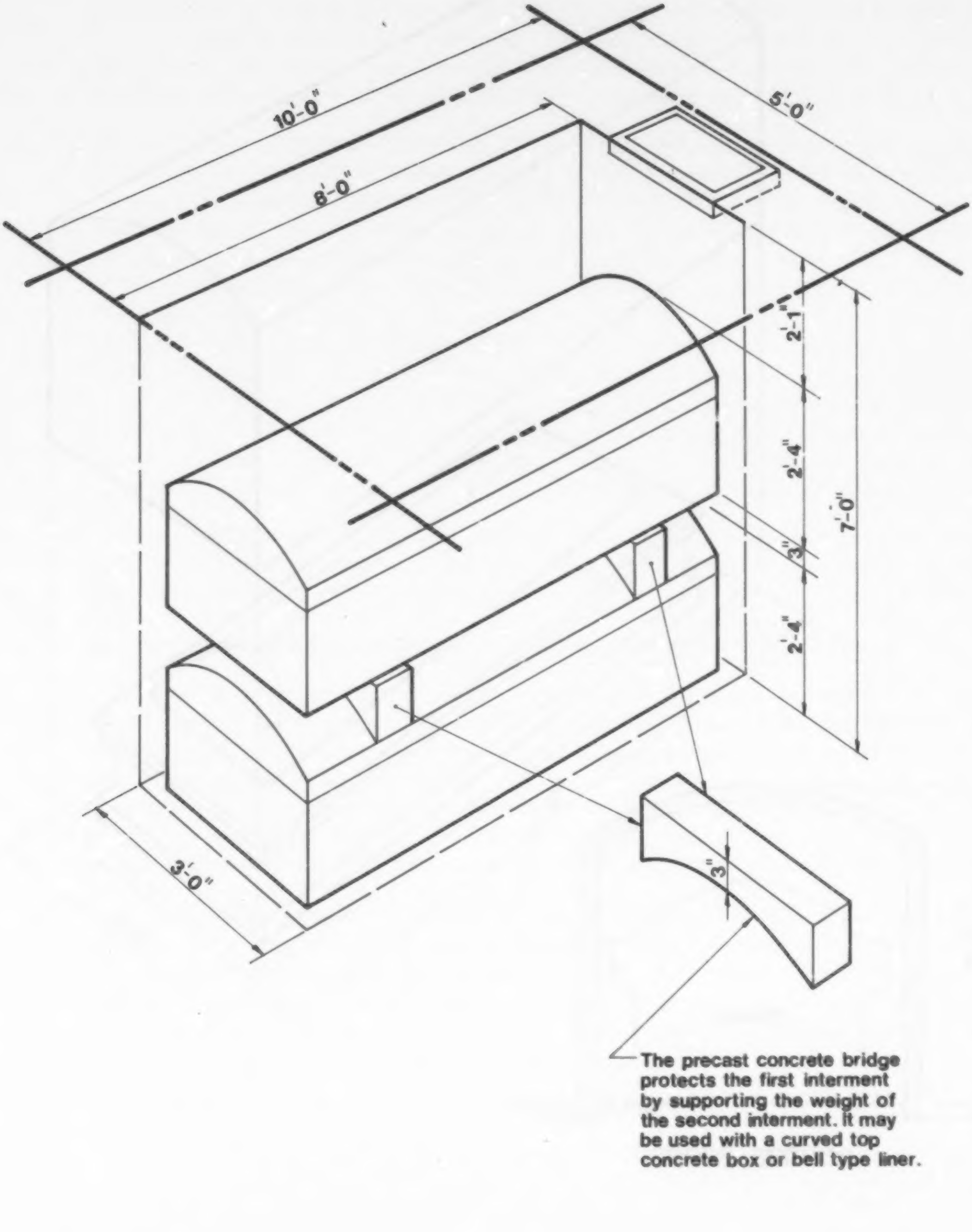
Bell liners are, in general, less costly and present fewer problems. Observations made and testimony gathered indicate that they do not trap seepage water. On the other hand, in conditions of high groundwater they would of course permit groundwater to fill the grave, although air trapped under the bell by rising groundwater could prevent water from rising within the bell itself. Bell liners avoid serious coordination problems since they are placed after the caskets have been lowered into place. Fiberglass bell liners can be handled by one man manually. However, as currently manufactured they appear more suitable, because of load limitations, for 5 ft. deep gravesites. It is, of course, feasible to produce fiberglass bells that will resist heavier loads, but they then might not be able to compete economically with precast concrete bells.

There is a third, cast-in-place, alternative that has been proposed for use, in which the casket is encased in an evacuated, airtight plastic bag, lowered into position, and then backfilled with a dry mix of portland cement and fine aggregate (to at least an inch above the top of the casket). This backfill is then sprayed with water and allowed to set up as a concrete liner. It would be impractical to attempt this method unless the soil was such as to permit narrow excavations with nearly vertical walls.

(b) Appropriate Types of Markers

Both of the predominant types of markers used in the National Cemetery System, upright and flat, permit appropriate memorialization, but each has a different impact on esthetics and maintenance. Most of the system has until recenlty utilized the upright marble headstone which is simply embedded in earth at the head of the gravesite. This system creates a strong visual impact of monuments in severe rows and is strongly favored by those who feel that memorialization is what the cemetery is all about; also, it is the strongest parallel, within the strictures of standardization and non-discrimination, to the traditional graveyard of ornate headstones with which most Europeans and Americans have grown familiar. There has been a significant and relatively rapid shift, however, in the public's acceptance of alternative interment methods in the private sector in the last decade—underlain by the driving force of economic pressure. This extends from the more common use of garden crypts and multiple-layered lawn crypts for conserving land to the use of flat markers in an attempt, not always successful, at minimizing maintenance costs. As used in the National Cemetery System flat markers are usually cast-in-place concrete pads to which are attached bronze marker plates or are flat stones.

There is not enough data at our disposal at this time to determine the impact of flat markers on maintenance costs. The responses of cemetery directors we queried indicate that trimming work, largely around headstones, is nearly equal to or exceeds other normal lawn maintenance work. From our observations, trimming work is not materially reduced through the use of flat markers. This is because grass spreads laterally over the flat marker and has to be cut back virtually to the same extent that grass against the upright marker escapes normal mowing and requires trimming. The biggest difference should be in mowing operations where economies can be realized with flat markers by using wide gang mowers, and are—in the private sector. This saving is, of course, only theoretical if "flat" areas continue to be mowed with the narrow mowers required in "upright" areas—as was observed on several occasions. In the long run, however, these economies should become evident. The situation is not quite so clear with regard to the rate of replacement of damaged and deteriorated markers. All markers are subject to inadvertent damage during sinkage repair, maintenance and reopening operations. Our observations indicate that flat markers are more subject to



The precast concrete bridge protects the first interment by supporting the weight of the second interment. It may be used with a curved top concrete box or bell type liner.

DOUBLE INTERMENT, 5'x10' GRAVESITE WITH CURVED TOP LINERS OR VAULTS

Figure 5.2

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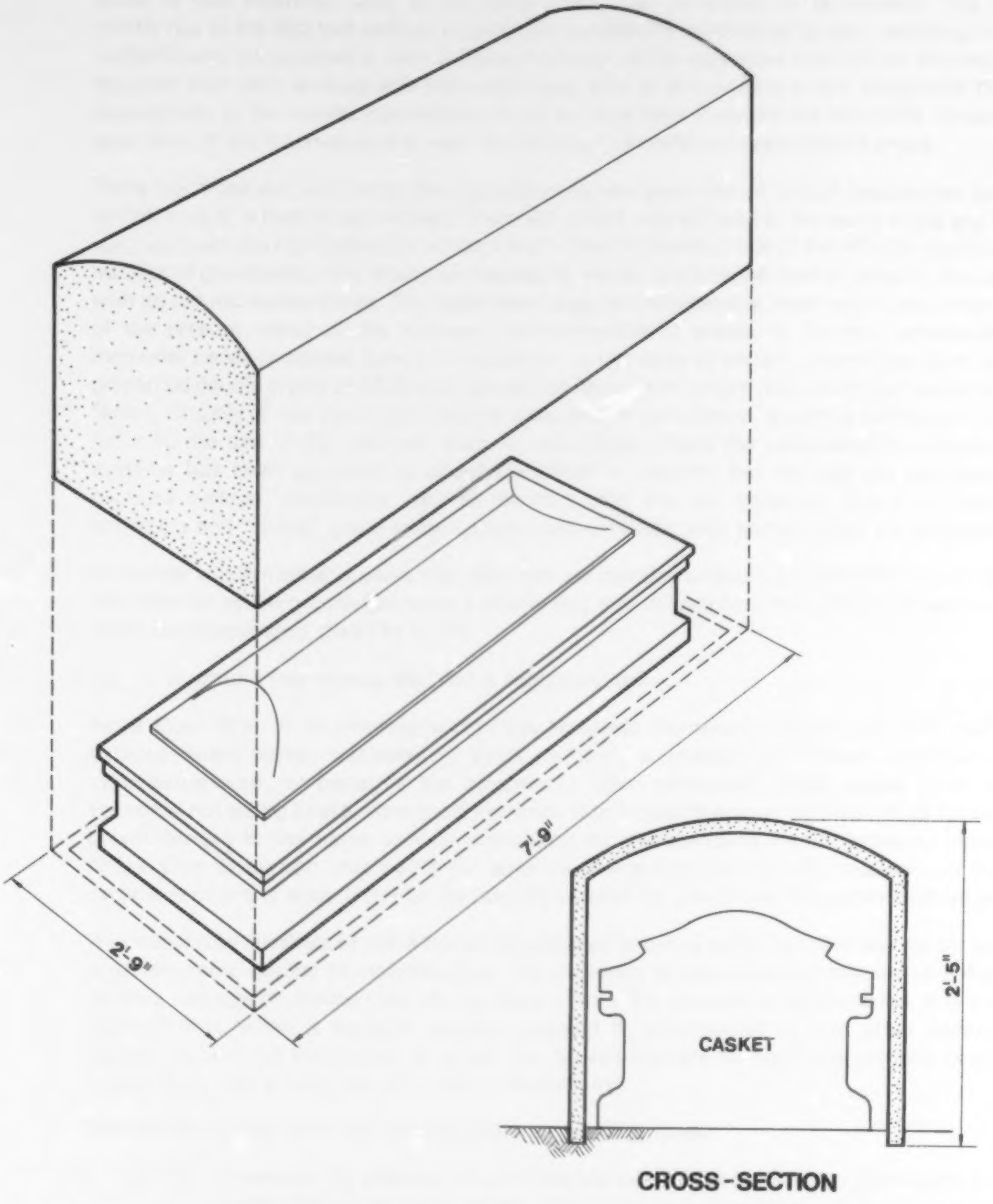

PRECAST CONCRETE BELL LINER Figure 5.3

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wheel damage than upright markers—simply because the driver of the vehicle is not as aware of their locations. Also, normal deterioration can be greater in flat markers. This is mostly due to the fact that vertical markers are periodically washed off by rain, removing the contaminants transported to their surfaces from the soil or deposited from the air; whereas, deposits from both sources and from acid rains, tend to accumulate in and deteriorate the depressions of flat marker inscriptions. It will be important to record the economic impact, over time, of flat markers on the sum of maintenance costs and replacement costs.

There are those who will insist they are stirred by row upon row of upright headstones but are left cold by a field of flat markers. There are others who will look at the same scene and it reminds them of a rigid stoneyard without any of the haphazard grace of the infinitely variable traditional graveyards; they would be happier to see an uncluttered field of grass in repose with its natural surroundings. The latter view takes on considerable merit within the context of the present policy of the Veterans Administration to create, in its new cemeteries, memorial parks of natural form and ambience. In the case of certain alternatives, such as preplaced double crypts or 3.5 ft. wide gravesites, the use of upright markers would create the feeling virtually of row upon row of stone walls and, in our opinion, would be esthetically inferior to the use of flat markers. Also, in cemeteries where the installation of irrigation systems has been approved to offset the effect of drought, flat markers are preferable because vertical headstones tend to interfere with the low trajectory sprays of many sprinklers and "shade" grass areas on the sides of headstones farthest from the sprinkler.

No matter which marker is used, it is clear that the practice of pouring weed killer around its perimeter to inhibit growth produces a yellow ring that is unsightly; the practice should certainly be discouraged. (See Photo 3.4)

(c) Inground Interments Without a Durable Liner

More than 25% of interments within the National Cemetery System are still made without liners either because of local preference, inability to obtain liners at a reasonable cost, or because the interments were reopeners made above prior interments not using liners. Interments without liners meet the tests (a) through (d) for appropriateness in the same way as discussed for the standard 5′x10′ gravesite using liners. One exception that could be taken is that a liner is normally available in the private sector and should not be denied the veteran on insufficient economic grounds.

It is debatable whether or not a bona fide attempt is being made to meet test (e) for appropriateness, quality of maintenance, if a cemetery is permitted continually to suffer serious sinkage problems that visibly detract from the cemetery's appearance. It is our opinion that, when a sinkage problem caused by environmental and other factors begins to become excessive, it would not be appropriate to continue without liners unless they had a relatively low cost effectiveness.

The following two rules for appropriateness are suggested:

(1) Wherever the present value of the life cycle cost of interring with liners exceeds that of interring without liners by less than 10%, liners should be used to achieve a better appearance.

(2) Whenver the existing sinkage factor, as defined in Chapter 8, of a cemetery exceeds 1.25, liners should be used to reduce sinkage problems and achieve a better appearance.

5.3 Inground Interments — 6′x10′ Gravesite

Again, the 6′x10′ deep gravesite, as depicted in Figure 5.4, using liners meets tests (a) through (e) for appropriateness in the same manner as does the 5′x10′ gravesite. In some respects it exceeds the 5′x10′ gravesite with respect to test (b) by offering the veteran and his spouse side-by-side burial rather than one over the other.

The economic appropriateness of this alternative should be measured in terms of its cost effectiveness when compared with the 5′x10′ gravesite. Whenever the 6′x10′ gravesite is approved for use because of high groundwater, high bedrock, collapsing sands, or other unmanageable soil condition, the increase in productivity that derives from switching to the shallower gravesite should result in its being found more cost effective or, at worst, as cost effective.

5.4 Inground Interments — 3.5′x9.5′ Gravesite

Test (b) for appropriateness, grave size and interment arrangement, is the principal difference between this alternative and the 5′x10′ gravesite. A 3.5′ wide and 9.5′ long gravesite is judged to be the minimum gravesite that would be appropriate for national cemetery operations given the 2′-11″x7′-9″ size of oversize liners, the rapid pace at which the larger active cemeteries are required to work in close quarters, and the need to leave room for the possibility of installing irrigation mains. It is difficult to take the position that a 3.5′x9.5′ gravesite is inappropriately small since the private sector commonly offers a smaller gravesite. However, there are problems with handling dependents in a satisfactory manner. The veteran and one spouse can be interred one above the other beginning at the 7 ft. depth but there is no room to add a third interment, spouse or dependent child, side-by-side at the 5 ft. level as there is in the standard 5′x10′ gravesite, without an unacceptable degree of encroachment into adjacent gravesites. Accordingly, it would appear that, if such a system were adopted, the following management rules would be appropriate:

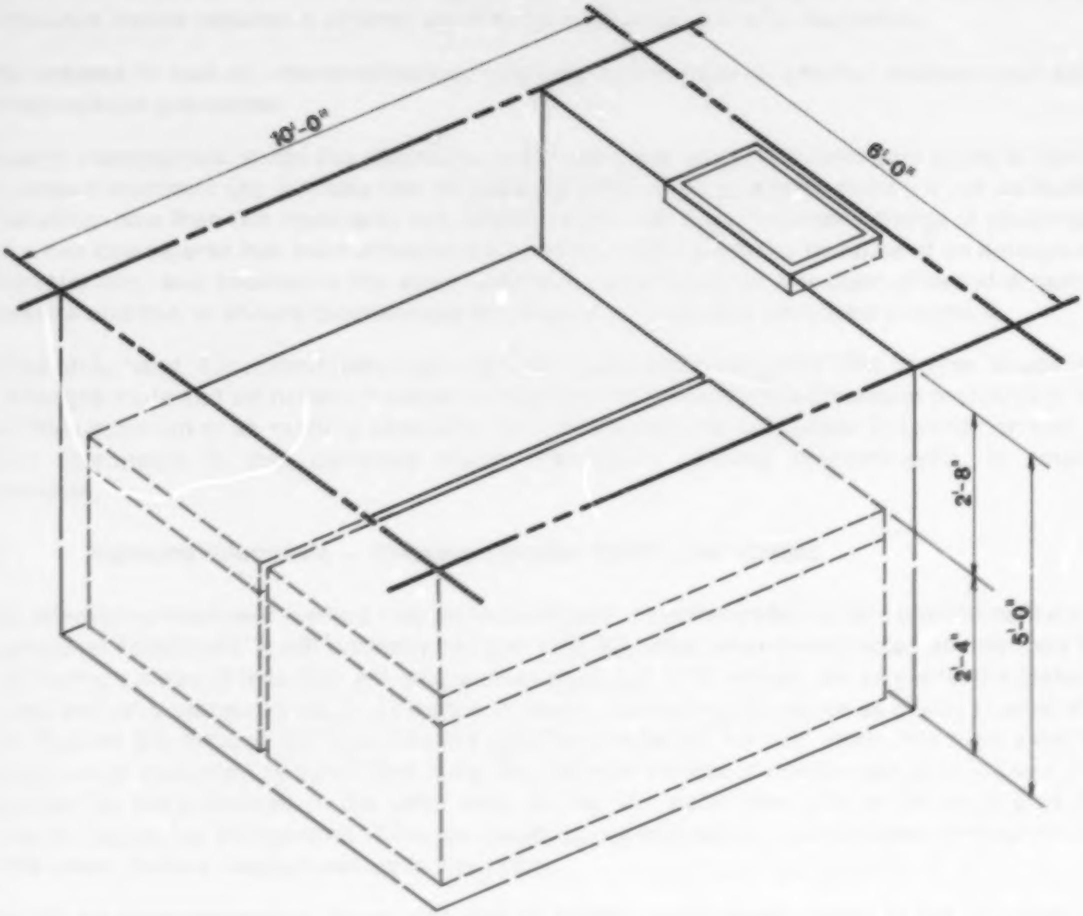
(1) If the first interment were a veteran's wife or child or if he had a handicapped child, two gravesites would be assigned—one reserved for a second wife or child. This is estimated to represent 5% to 6% of the total.

(2) If the first interment were the veteran and there were no handicapped or chronically ill children, one gravesite would be assigned.

(3) If a third interment were required where a single gravesite had been assigned, the first two would be disinterred to permit the third to be buried in the same gravesite.

In cemeteries where soil conditions permit 9 ft. deep excavations without soil collapses, a three-layer burial system would be a more cost effective alternative than reserving gravesites for third interments. Fourth interments are extremely rare but, if they occurred, would have to be handled under a three-layer system either by disinterments or by interment in a separate gravesite.

Where deep excavations are not possible, a reservation system must be used for anticipated third interments. A true reservation system is difficult and costly to administer. In its stead we would recommend establishing a special area of 6′x10′x7′ gravesites capable of handling up to four interments each. To the extent that the cemetery administration accurately assesses the probability of a third interment, this special area will achieve a high degree of utilization.



DOUBLE INTERMENT, 6'x10' GRAVESITE WITH CONCRETE LINERS

Figure 5.4

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One drawback to 3.5′ wide gravesites is that, if they are dug sequentially, a continuous open trench is created that has a negative emotional impact if viewed by cemetery visitors. When employed, therefore, it would be preferable to use a "leapfrog" excavation plan (1, 3, 5, 7 etc. on one day and 2, 4, 6, 8 etc. on another day) or (1-2, 5-6, 9-10 etc. on one day and 3-4, 7-8, 11-12 etc. on another day). The first of these methods is the most economical in terms of excavation. It requires a 36 inch width of soil to be handled per grave whereas the second requires a 39 inch width and a continuous trench requires a 42 inch width to be excavated and later backfilled.

With respect to test (c), memorialization, it is only appropriate to use flat markers with such closely-spaced gravesites.

It seems inappropriate to use this alternative in any cemetery where sufficient land exists to handle the present interment rate for more than 10 years using the 5′x10′ gravesite, since it is not as flexible in handling more than two interments in a veteran family unit. Also, it invites a charge of discrimination when one veteran has been afforded a 6 ft. wide double gravesite because of an anticipated third interment and another in the same essential circumstances has been afforded a narrow gravesite and has to endure disinterment because of an unanticipated third interment.

On the other hand, it is undoubtedly cost effective, usually by a margin of 10% or more, to use this smaller gravesite and we believe it would be appropriate to employ this interment prototype to extend the useful life of an existing cemetery. This should be done only under the condition that *all* future interments in that cemetery would take place, without discrimination, in smaller gravesites.

5.5 Inground Interments — Preplaced Double Depth Lawn Crypts

This alternative interment method may prove to be cost effective under certain environmental and operational conditions. It will normally be most cost effective when constructed on relatively flat land having a slope of less than 4% where an average cut of 30 inches can be made; the material stored; and later placed on top as 18 inches of cover—and along the edges as gently sloping side fills. Figures 5.5 through 5.7 illustrate the prototype selected for this study. We have selected precast units spearated by sand filled slots for drainage instead of continuous cast-in-place construction for the prototype. In the latter case all the rain water that falls on the crypt area has either to stay within the topmost 18 inches, causing over-saturation, or drain down through cracks in the cover system—accumulating in the crypts.

Test (b) for appropriateness, grave size and interment arrangement, again is the principal difference between this alternative and the 5′x10′ gravesite. The double depth crypt has the same flexibility limitations regarding more than two interments in a veteran family unit as does the 3.5′x9.5′ gravesite and would be subject to the same management rules outlined there. As with 3.5′x9.5′ gravesites a three-layer crypt system would be more cost effective than reserving a second double depth crypt for potential third interments. A given percentage of triple depth crypts would be preconstructed in a special area of the cemetery, the number determined by the cemetery's prior experience with having to decide that a third interment is probable. An alternative to triple depth lawn crypts would be a special area of 6′x10′x7′ gravesites. While they would very likely not be as cost effective as triple depth crypts, these wider gravesites would have the advantage of having room for a fourth interment.

One major advantage of preplaced crypts over grave excavating alternatives, especially for cemeteries having over 1,000 interments annually, is the limited sense of disturbance that can be achieved, thereby improving the overall appearance of the cemetery for visitors. This is so because it becomes practical to establish a full mat of grass; peel it off prior to interment; only have to remove a very small quantity of soil during daily interment operations; and, replace the sod immediately afterward. Figure 5.7 depicts a row of sequential crypts ready to receive interments. If handled well, the cemetery will always have the finished look of traditional private sector cemeteries where daily interments are usually never sequential and therefore very little disturbance is evident in any one sector.

The question of the economic appropriateness of preplaced crypts should be resolved by their cost effectiveness compared with 5'x10' gravesites. There are more serious economic consequences, however. This alternative requires a large capital investment, far in excess of the capital outlays required for preparing inground burial sites. This implies a major shift in funding policy that may or may not be acceptable to Congress. Conversely it implies an increase in interment productivity which can only be realized as a savings if there is an accompanying reduction in interment man hours.

Taking all these factors into account, it appears especially appropriate to consider this alternative in an existing cemetery with a high annual interment rate and environmental influences causing it to have a low interment productivity rate—in order to extend the useful life of that cemetery. Under those conditions it would probably be clearly cost effective and interment personnel could be readily reduced by transferring them to the rehabilitation work that normally requires a buildup of maintenance forces during the closing years of a cemetery. In a new cemetery, the staffing can be tailored to the requirements of lawn crypts. Again we believe it should be employed only under the condition that all future first interments in that cemetery would take place, without discrimination, in lawn crypts.

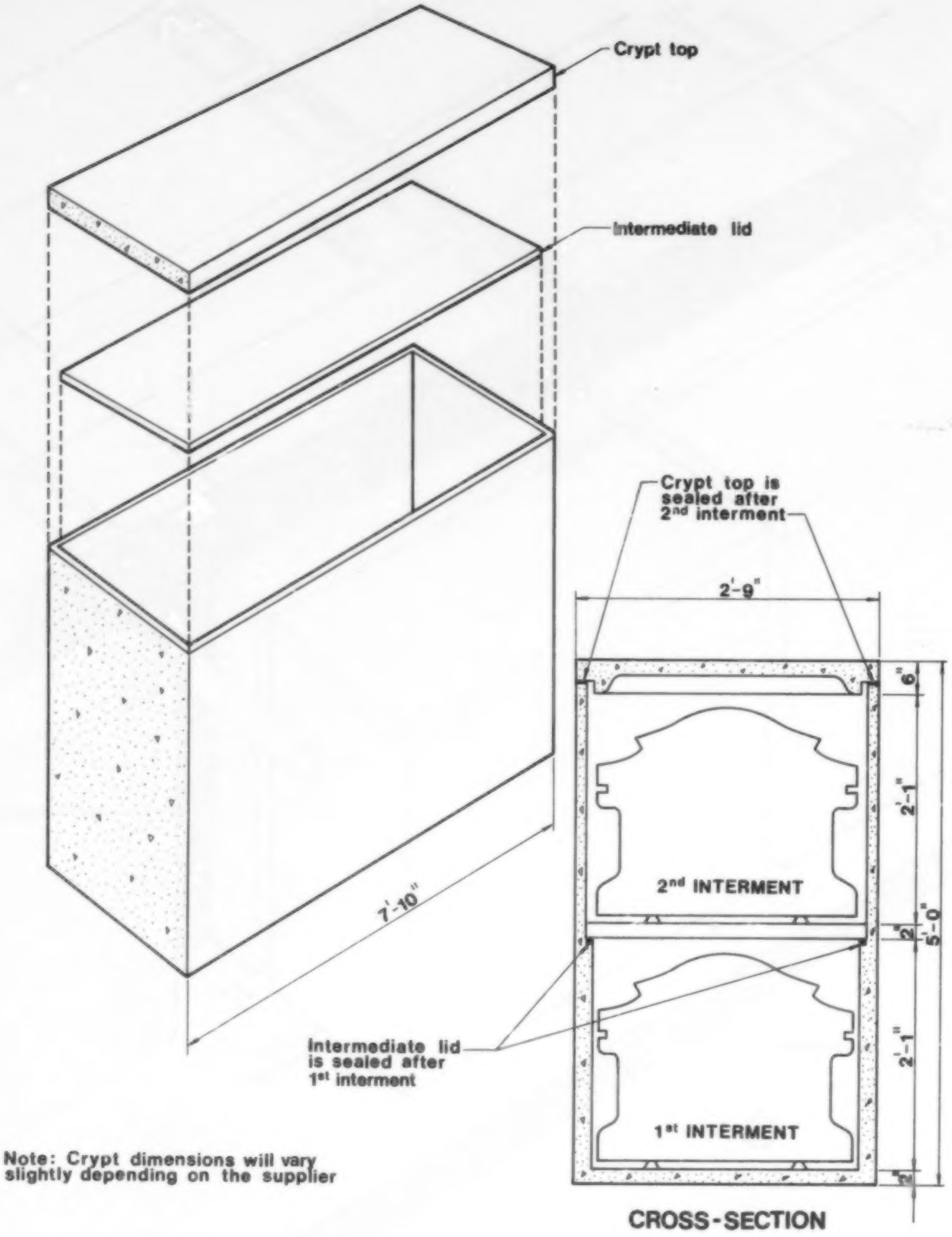
5.6 Above Ground Interments — Garden Crypts

Our analysis of costs indicated that, in order to be remotely cost effective, garden crypts would have to be designed to minimize the impact of stone cladding and foundations on crypt costs. A study (Ref. 5.1) was done for Willamette N.C. that developed high densities and low unit costs by memorializing those interred in the garden crypt at one central location remote from the actual crypts. This avoids the need for individual stone covers and solves the more important management problem of how to bury sequentially and handle the variable nature of the veteran family unit. Without that feature, it would become extremely difficult ot achieve a high percentage of utilization—and it is essential that close to 100% utilization be achieved.

We have proposed a prototype, for economic comparisons, consisting of basic modules having 1,024 crypts of the size depicted in Figure 5.8 arrayed 7 rows high, with 2 crypts on one side of a service aisle and 3 crypts on the other side. Figure 5.9 shows two modules parallel to a pull-out drive in an informally designed cemetery. The common area between modules is used for committal services and central memorialization. Funerals would park along the pull-out drive. Figure 5.9 also shows another configuration, of three modules, again with a central committal service and memorialization area, that might be worked into an informal design. It produces a greater density than the two-module concept. These prototypes meet the tests for appropriateness as follows:

(a) The structure itself is designed to incorporate an appropriate committal service area.

(b) The crypt sizes would be the equivalent of those available in the private sector, where it is common to purchase a group of adjacent crypts for the whole family. It would be impractical to attempt to arrange adjacent family interments in national cemetery garden crypts because of the haphazard and uncertain occur-


Crypt top
Intermediate lid
7'-10"
Crypt top is sealed after 2nd interment
2'-9"
6"
2'-1"
2nd INTERMENT
2"
5'-0"
2'-1"
1st INTERMENT
2"
Intermediate lid is sealed after 1st interment

Note: Crypt dimensions will vary slightly depending on the supplier

CROSS-SECTION

TYPICAL PRECAST, PREPLACED, CONCRETE DOUBLE DEPTH LAWN CRYPT Figure 5.5

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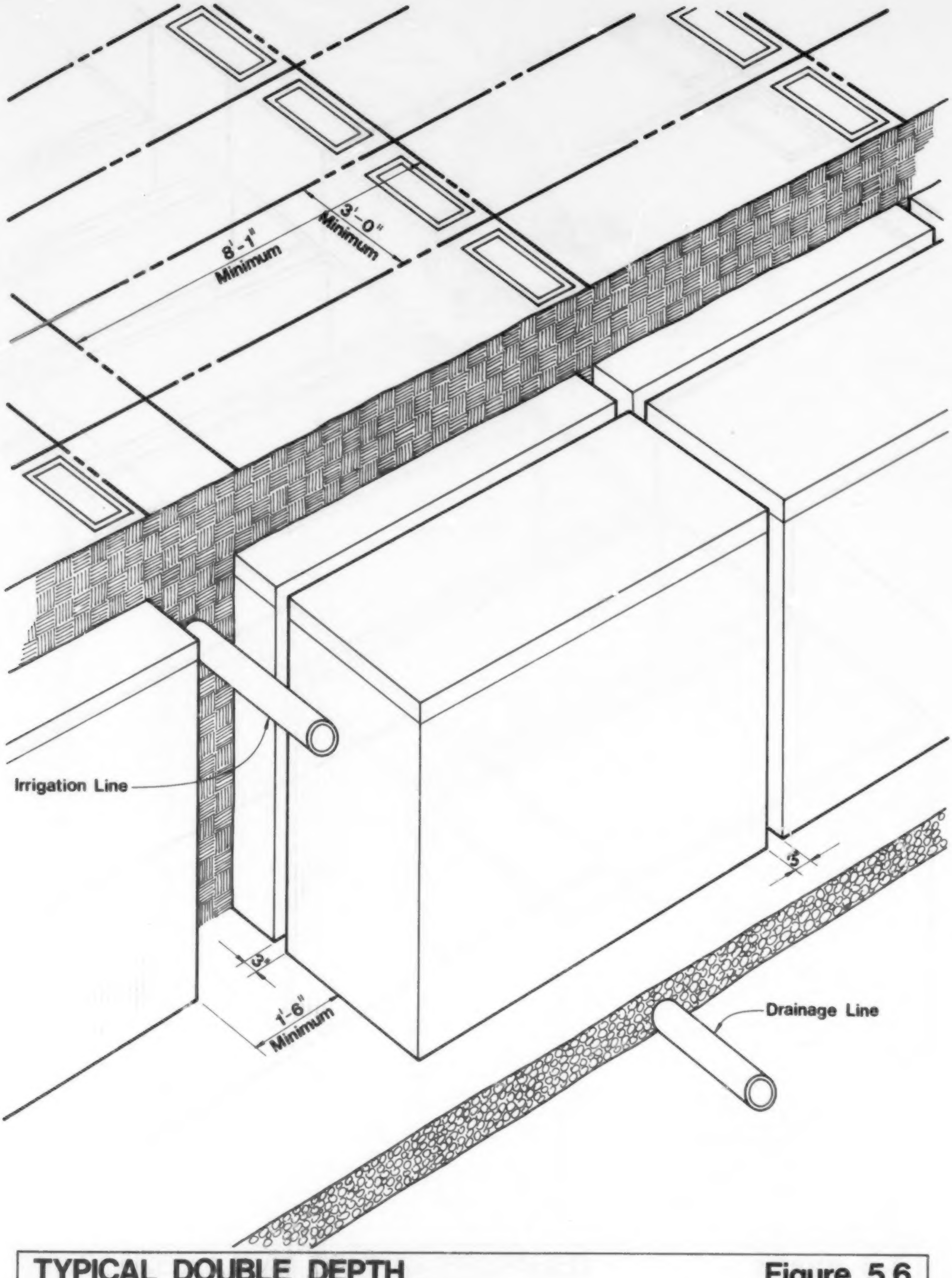

TYPICAL DOUBLE DEPTH LAWN CRYPT INSTALLATION

Figure 5.6

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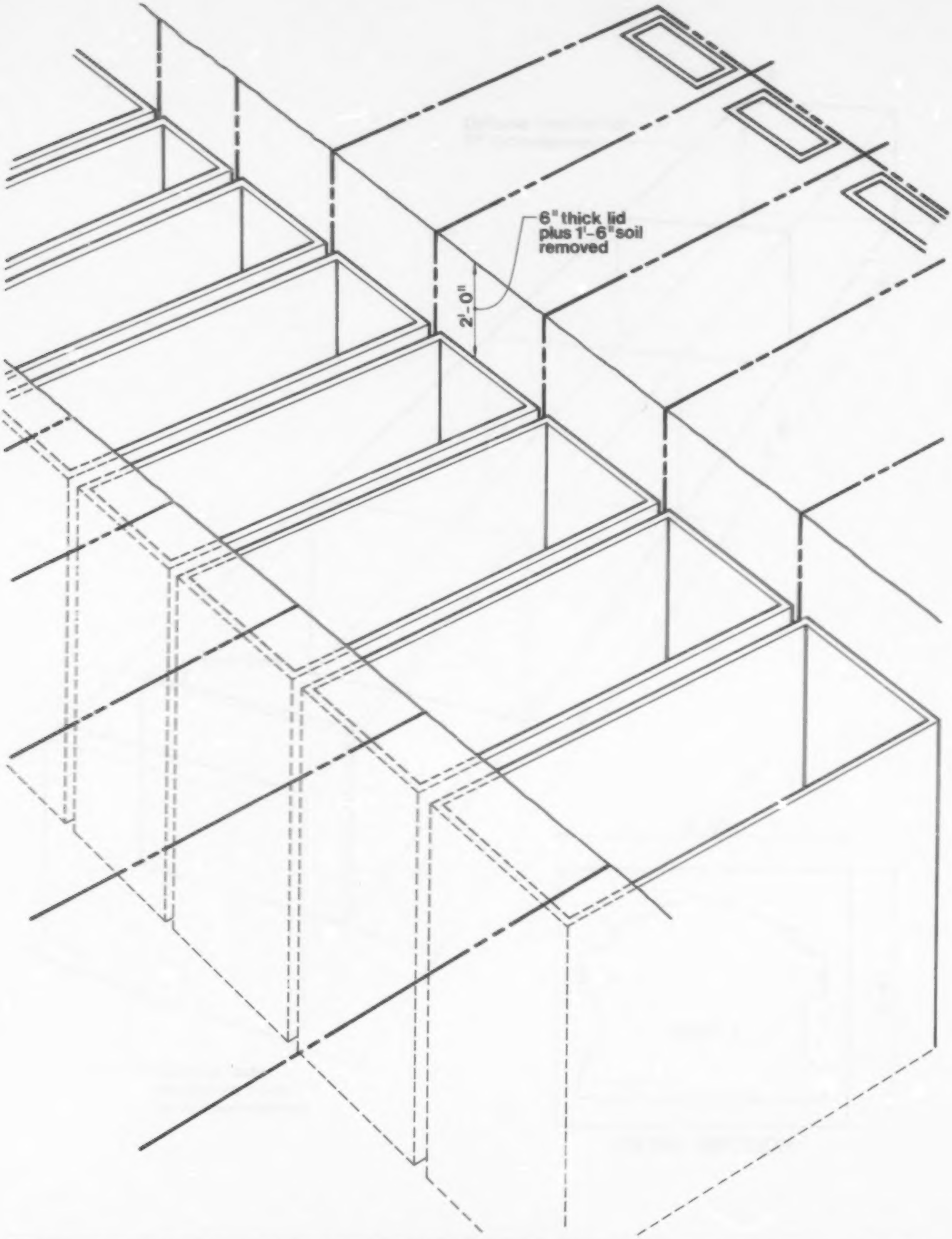

PREPLACED LAWN CRYPTS PREPARED FOR SEQUENTIAL INTERMENTS Figure 5.7

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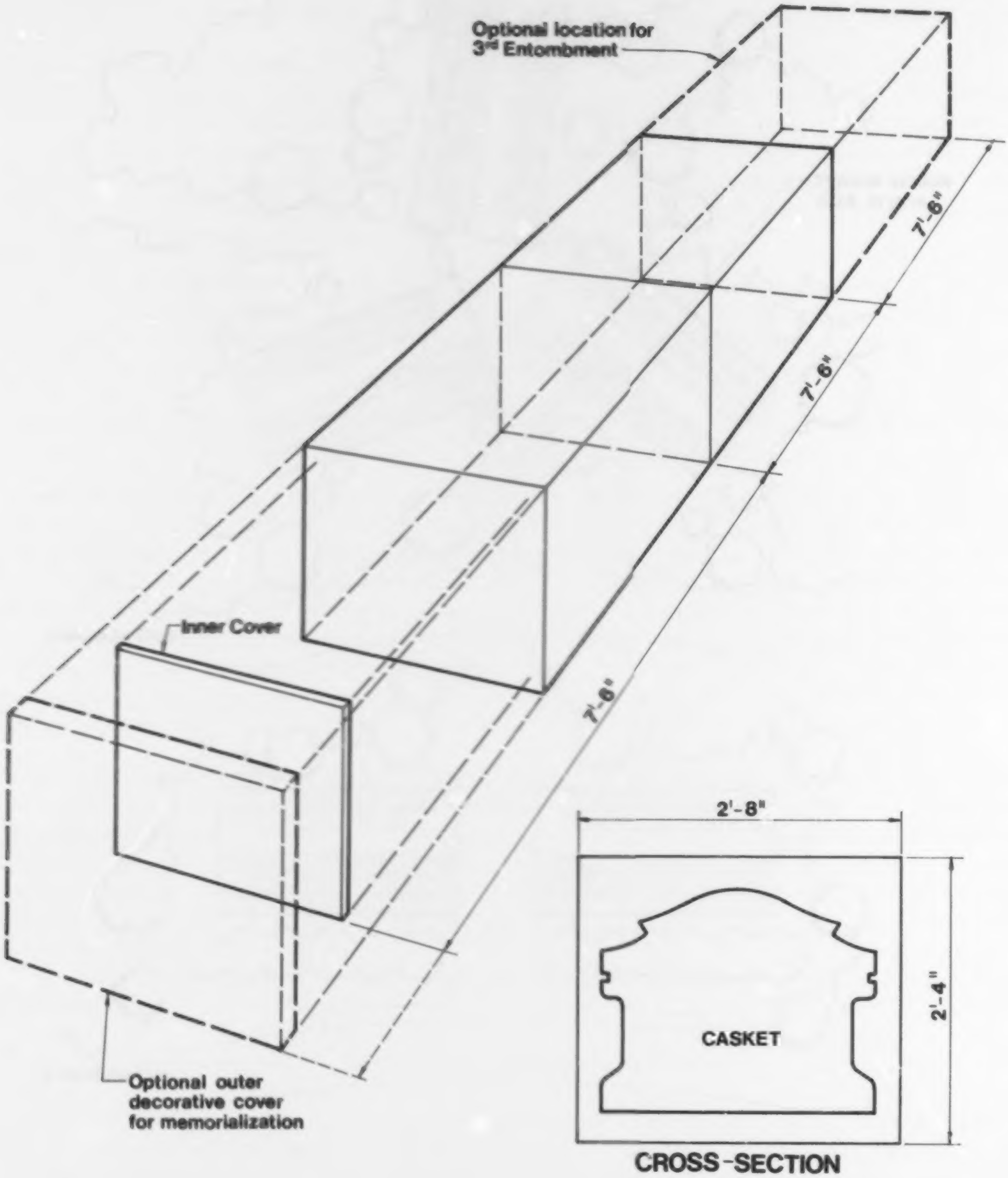

ABOVE GROUND GARDEN CRYPT GRAVESITE FOR CASKETED REMAINS Figure 5.8

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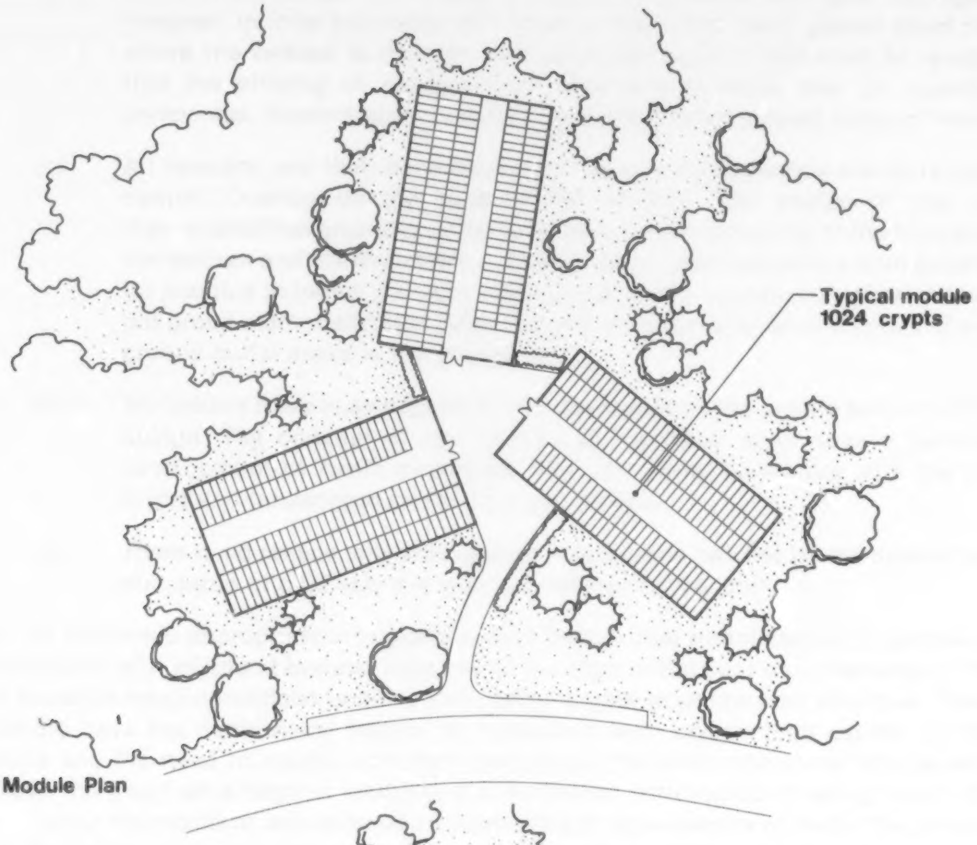
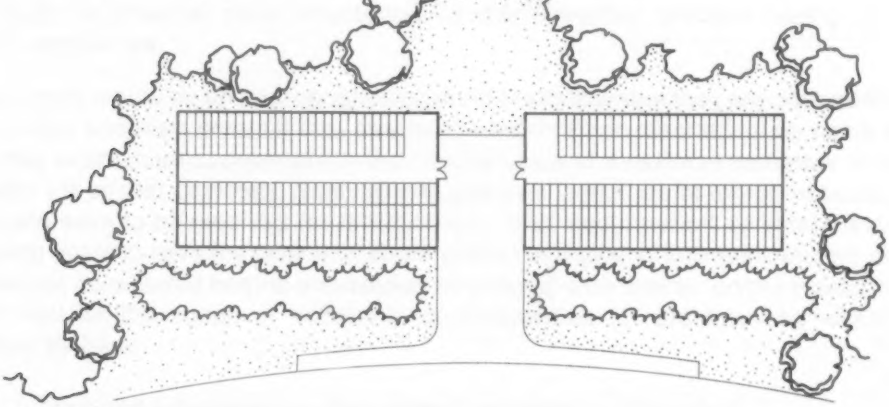


3 Module Plan



2 Module Plan

GARDEN CRYPTS Figure 5.9

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rence of dependent interments. It should be possible with good management, however, to inter each veteran's dependents in the same garden crypt module where the veteran is interred. One potential problem that must be resolved is that the offering of above-ground interment to some may be regarded as preferential, discriminatory treatment by those who are offered inground interment.

(c) All veterans and their dependents can be very appropriately memorialized at a central location on the face of the module. The design of the central memorialization area should be such as to permit grouping of the memorials to the veteran and his dependents. This is the greatest departure from private sector practice in terms of crypts, which customarily contain individual memorials; but group memorialization does occur in multiple level lawn crypts and even inground burial areas in the private sector.

(d) We believe there is an opportunity to improve upon the private sector in terms of design. The concept of not identifying individual crypt spaces permits the development of rustic structures that can better harmonize with the natural forms and landscapes of the new cemeteries.

(e) There is no reason why such garden crypt areas can not be maintained to high standards at relatively low cost per veteran family unit.

The test for economic appropriateness again should be the cost effectiveness of garden crypts when compared with inground burials. Because of the high initial cost of construction, it is difficult to visualize many conditions under which garden crypts would be cost effective. This alternative would have the same fiscal impact as preplaced lawn crypts: high capital funding requirements and the need to reduce interment personnel. The prototype under discussion here would have the great advantage of avoiding discrimination with regard to assignment of crypt ocations, since the locations would remain unidentified; that problem is solved in the private sec- or through incremental price structuring—a discriminatory practice having no pertinence in national cemeteries.

Garden crypts would be an appropriate interment method where they are cost effective compared o both liners and lawn crypts if they can be offered on a non-discriminatory basis to all veterans. Again they seem more appropriate in the closing years of a national cemetery in order to extend he useful life of that cemetery. Some ethnic groups will still prefer inground burial, so that some and would have to be reserved for that purpose. That would permit all veterans' families during he closing years to have the choice of above ground or inground interment without discrimination. We have not considered heated mausoleum structures with interior crypts inasmuch as their cost s well outside the scope of economic considerations for ordinary use within the National Cemetery System.

.7 Inground Interments — Obstructed Gravesite for Cremains

This method, depicted in Figure 5.10, is the typical National Cemetery System method used for the interment of cremains. A 5'x5' gravesite has been adopted for this prototype to establish economic arameters, although the exact size of obstructed gravesites varies considerably.

meets all the tests (a) through (e) for appropriateness in exactly the same manner as the 5'x10' ravesite for casketed remains. It is the cremains interment method that should always be used so long as partial gravesites occur as a result of obstructions. Otherwise those areas, which involve land, site development and perpetual maintenance costs that must be incurred in any event, would result in no interment benefits to offset those costs.

5.8 Above Ground Interments — Columbaria Walls

For the purposes of this study we have adopted a niche size 10" wide x 10" high x 12" deep as depicted in Figure 5.11. This size accommodates at least two containers of the largest sizes available in the current market.

The prototype being considered, as depicted in Figure 5.12, is one that might be appropriate for one of the newer informally designed cemeteries. It indicates an informal arrangement of free-standing columbaria walls typically 2 niches wide and 6 niches high. The plan includes a central area for committal services and a pull-out drive for parking funerals. It meets the tests for appropriateness as follows:

(a) The plan incorporates an appropriate committal service area.

(b) The niche size would be equal to that available in the private sector.

(c) In this type of prototype design the veteran and his dependents would be memorialized on the stone facing on the niche either by inscription or by attaching a bronze memorial. Either is fully equivalent to the private sector.

(d) There are an infinite number of columbaria wall garden designs possible. Each cemetery has its own special natural and design environment that should be respected.

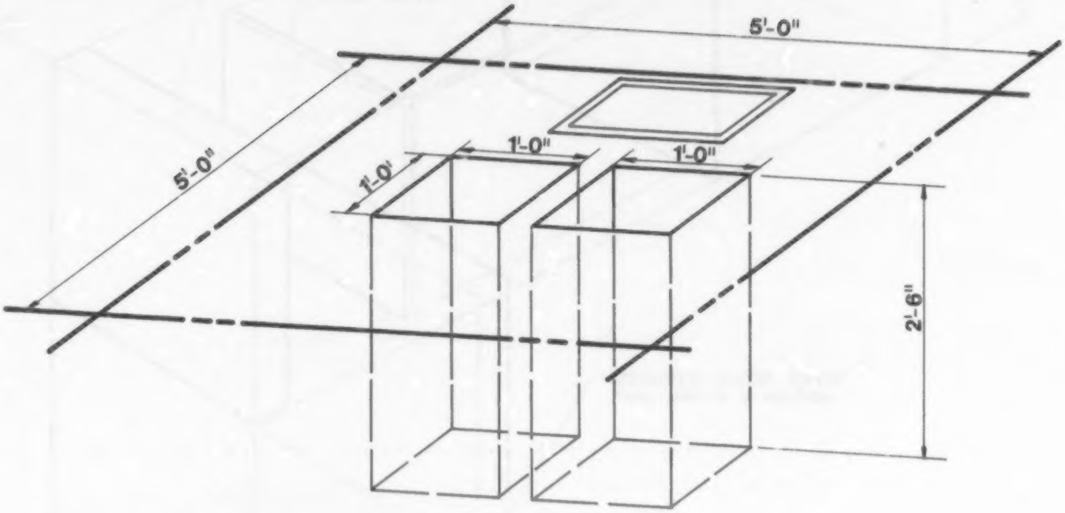
(e) There is no reason why such columbaria walls cannot be maintained to high standards at a relatively low cost per veteran family unit.

5.9 Add-On Columbaria Niches

The typical add-on columbaria would occur where a building or wall were required for some purpose within the cemetery and it was appropriate to add niches to the faces of the walls. Figure 5.13 illustrates the addition of niches to the walls of a permanent committal shelter. The structure required to support the columbaria niches under such circumstance, in a sense, costs nothing. If in turn the building or wall would normally be clad with stone suitable for conversion to niche face stones, as is the case in Figure 5.13, the niche faces would cost next to nothing.

Another version of add-on columbaria is depicted in Figure 5.14 where a courtyard paved with stone supported on a concrete slab has been converted, at very little cost, to inground niches.

All the tests for appropriateness applying to columbaria walls apply here as well.



INGROUND GRAVESITE
FOR NON-CASKETED CREMAINS

Figure 5.10

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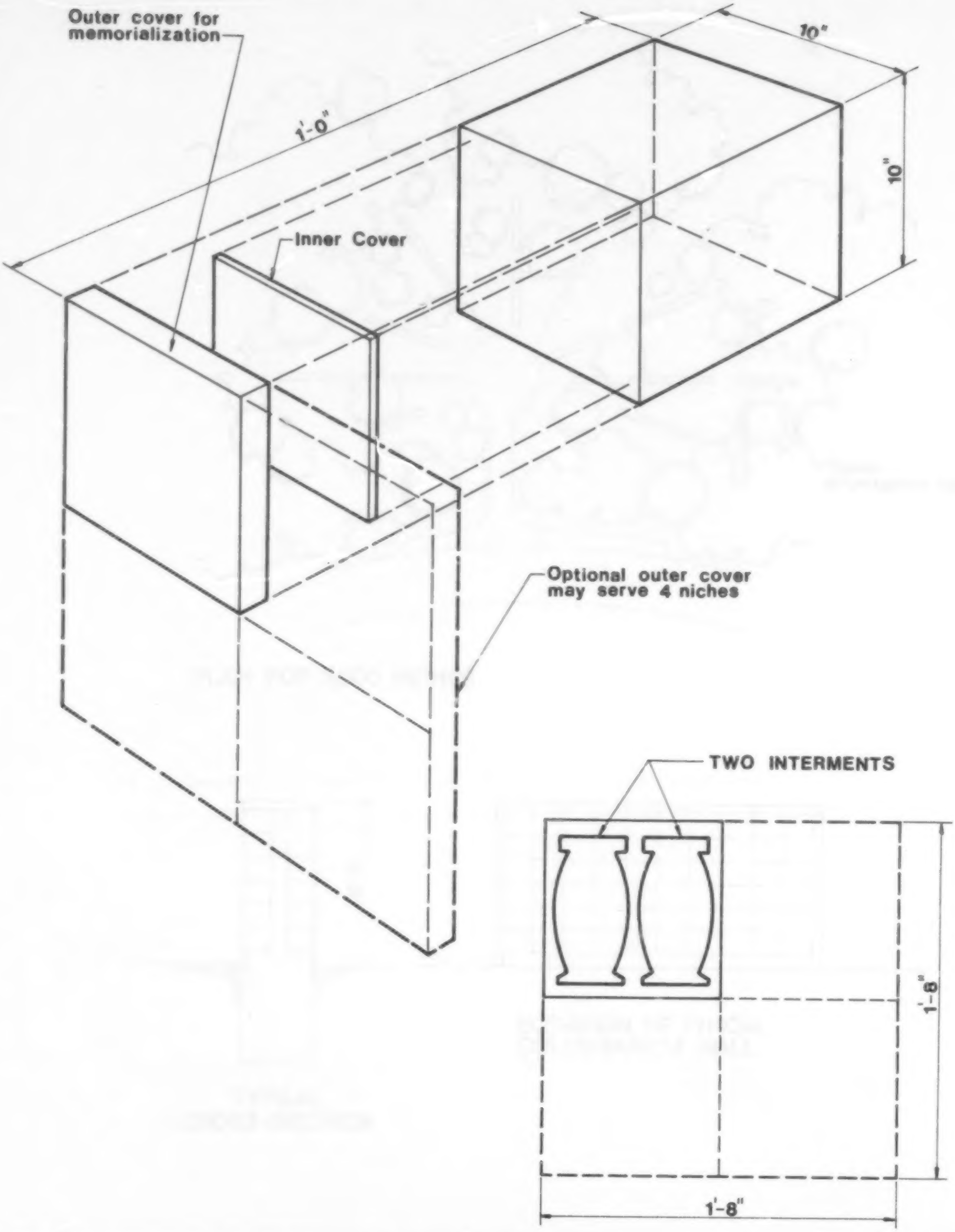
Outer cover for memorialization
1'-0"
10"
10"
Inner Cover
Optional outer cover may serve 4 niches
TWO INTERMENTS
1'-8"
1'-8"

ABOVEGROUND COLUMBARIUM NICHE FOR NON-CASKETED CREMAINS Figure 5.11

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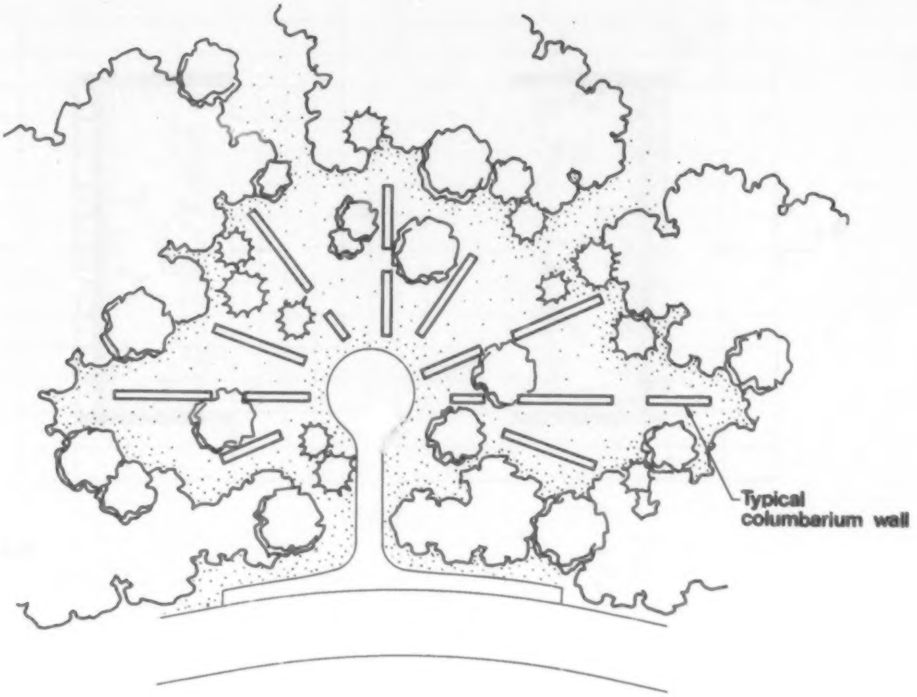
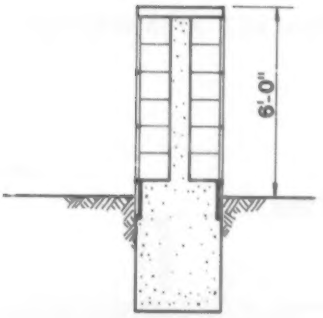
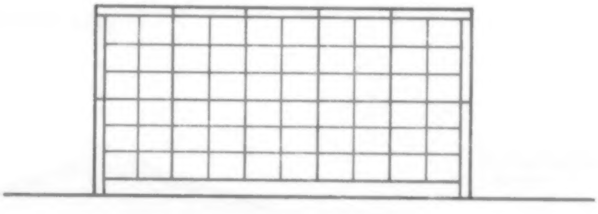


PLAN FOR 5,000 NICHES



TYPICAL CROSS-SECTION



ELEVATION OF TYPICAL COLUMBARIUM WALL

COLUMBARIA WALLS Figure 5.12

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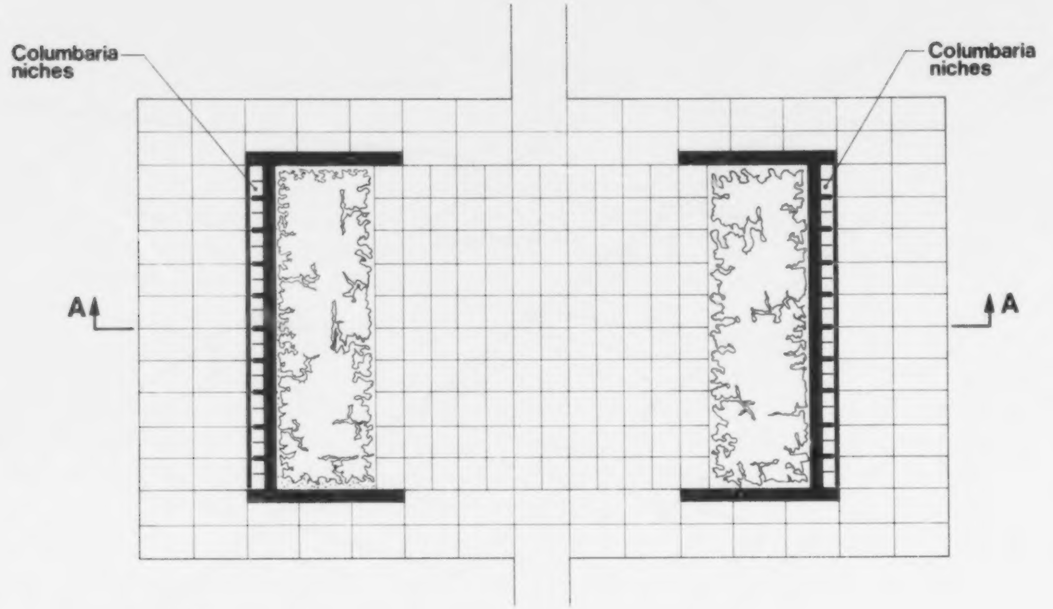
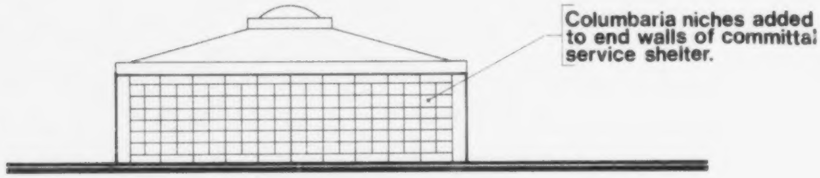
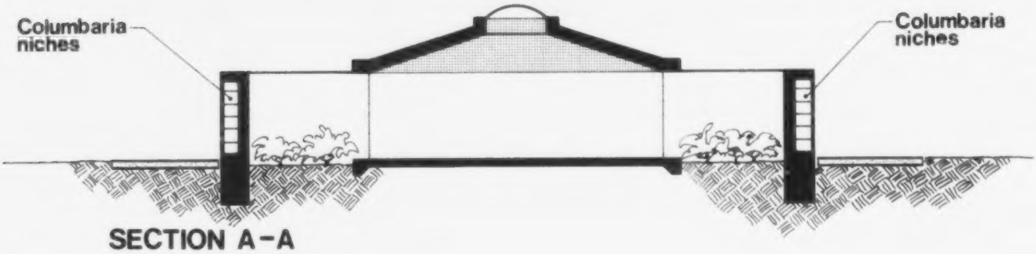


PLAN


Columbaria niches added to end walls of committal service shelter.

ELEVATION OF COLUMBARIA WALL



SECTION A-A

ADD-ON COLUMBARIA NICHES BUILDING INSTALLATION Figure 5.13

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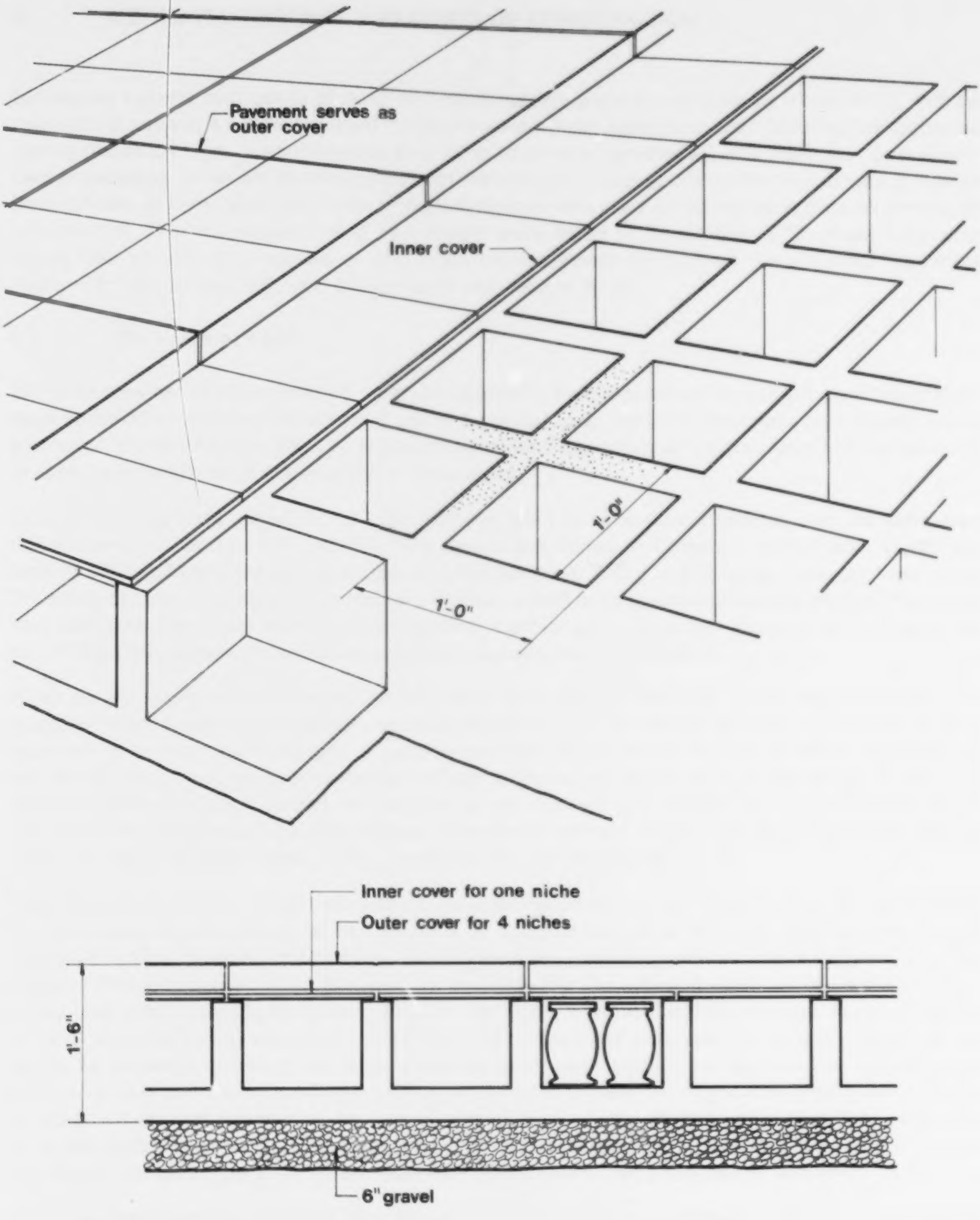

ADD-ON COLUMBARIA NICHES
TERRACE INSTALLATION

Figure 5.14

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6 ESTIMATED CURRENT UNIT COSTS OF CONSTRUCTION

Estimated current unit costs of land and construction were assembled by interpreting and extrapolating several studies provided by the Veterans Administration; from information gathered during the study from questionnaries and visits to private cemeteries; and from the consultants' own experience in recent construction cost trends. Little useful cost information was garnered from private cemeterians and product manufacturers who tend to regard such data as privileged information. The estimates of cost that follow were made in December 1979 unless otherwise noted. We anticipate a spread of unit construction costs throughout the National Cemetery System for the same prototype design of 30 per cent or more.

6.1 The Value of Land

While all new national cemeteries must, of necessity, be constructed on surplus land transferred from some other existing government use at no dollar cost, the land does have an intrinsic value. Moreover, the regulations (Ref. 10.1) governing federal benefit-cost studies require that the value of land be considered in the economic valuations.

One of the questions asked in the questionnaire sent to national cemeteries was the estimated current value of land in their vicinity. The responses, listed in Table 6-1, varied from $1,000 per acre to $250,000 per acre and averaged $45,000 per acre. There is obviously a danger here—that the value of land, if assigned too high a unit cost, could indicate an alternative method that uses less land was more cost effective than another method when in fact, if the cost of land were left out of the comparison, it would be considerably less cost effective.

What we are really trying to reflect by including land costs is that the interments are using up a valuable, irreplaceable commodity. Its realistic value is not so much the estimated value of land adjacent to an existing cemetery, a value which has escalated since the cemetery was started, but rather the current replacement value of land in that same community. Accordingly, for the purposes of economic comparison, we propose to use the unit cost of land in the general vicinity of any cemetery that would be inexpensive enough to warrant consideration of purchase by the Veterans Administration were it not compelled to use transferred land.

Even the private sector, which can recoup its land investments, must place practical restrictions on the amounts it is willing to pay for land. In speculative office building development, for instance, it is rare to spend much more for land than the cost to develop it into a finished site. We suggest that this guideline be followed for establishing the upper limit of the value of land; currently that would be approximately $30,000 per acre. A more realistic average value would be $15,000 per acre; its use would be consistent with (1) the more probable fair market value of land it would be possible to find if the land had to be purchased and (2) the general rule agreed to by OMB and GSA that transferred land (which would tend to have the higher fair market value, fixed by adjacent appraisals) should be reimbursed at 50% of fair market value (Ref. 6.1). Naturally there are cemeteries located in areas where land appropriate for cemetery development can be purchased for less than $15,000 per acre—in which case, that lower value should be used.

Using an average value of land of $15,000 per acre will result in a difference of approximately 4% in life cycle costs between 5'x10' gravesites and alternative interment methods that achieve densities per gross acre twice as high; that is, the impact of land values is to increase the cost effectiveness of the denser alternative approximately 4 percent. Such an impact adequately reflects the influence of land values without permitting them to have an unwarranted influence on the cost comparison of alternatives.

TABLE 6-1

Cemetery Code	Unit Cost of Liners (1)	Unit Cost of Permanent Markers	Estimated Value of Adjacent Land per Acre	Cost of Cemetery Development per Acre (year)
CA-1	(2)		$ 16,500	$ 12,500 ('58)
CA-2	(2)			15,170 ('63)
CA-3	(2)		250,000	
KS-1	$ 82.50		1,000	
OR-3	74.90	(4)	20,000	
NY-1	91.80	$ 60.00	30,000	15,500 ('76)
TX-1	65.00	(4) 50.00	4,000	28,535 ('79)
MN-1	83.00		40,000	29,870 ('76)
NM-1	(3) 86.00	79.08	3,000	35,715 ('76)
WI-1	73.75		20,000	
CO-1	47.95	68.00	65,000	16,070 ('69)
TN-4	84.50	57.50	163,000	
TX-3	50.00	46.44	1,600	
VA-2	107.00	77.72	1,500	30,000 ('78)
TX-2	89.00	73.00	6,000	
MO-1	95.00	56.33		71,430 ('77)
TN-3	79.35		6,000	
PR-1	(2)	(4)	100,000	21,000 ('65)
TN-5	84.49	77.00		
FL-1	(2)	73.00		6,331 ('77)
TN-1	80.00	87.25		
HI-1	(2)	(4) 54.15		
Average	$ 79.24	$ 66.12	45,475	

(1) Concrete liners delivered and placed except as noted
(2) Did not use liners in 1978
(3) Fiberglass liners delivered but not placed
(4) Flat granite. All others that reported costs were using upright.

6.2 Site Development

Site development includes the costs of roads, grading and drainage, preparing and laying out cemeteries, landscaping, irrigation, utility lines, and special site features. It does not include the costs of buildings for administration, committal services or maintenance. While the latter represent real costs attributable proportionally to all interments that occur, their inclusion would badly warp the influence of cemetery development costs on comparisons of cost effectiveness. This is so because the size and cost impact of these building facilities is related in the first instance to the annual rate of interments (administration, committal service) and in the second instance to the size of the cemetery already planned for development (maintenance). Both are quite variable factors having no fundamental relationship to the cost per interment. Perhaps even more important, in the typical situation involving cost comparisons of interment methods, the cemetery area that will be added, or used if already existing, will normally not contain, or require, any additional buildings for administration or maintenance.

On the other hand, site development costs relate directly to the number of gravesites that are provided by that development. In a new cemetery, or expansion of an existing one, they represent the costs that are to be spent currently to develop an area for interments. In a cemetery that has already been developed for interments, estimated current costs represent the present values of that site development that has already taken place.

We estimate that, depending on soil and local construction market conditions, the current costs of site development, under the relatively favorable topographical and soil conditions sought when selecting cemetery sites, vary from $30,000 per gross acre to $40,000 per gross acre throughout the National Cemetery System. Under very unfavorable topographic and soil conditions, the cost per acre can be substantially higher, perhaps as much as twice the cost.

6.3 Liners and Markers

Table 6-1 lists the reported costs of liners and markers in FY 1978 throughout the 22 larger sample cemeteries examined in this study. The average cost of liners was $80. They varied from $46 to $107, the maximum cost deemed economically justified in FY 1978. In FY 1977 the average liner cost had been reported to be $81 (Ref. 2.1). The FY 1978 average reflects a greater use of bell liners, which tend to be less expensive, in certain cemeteries.

In areas where concrete boxes with lids are higher than average in cost it will very likely be cost effective to use precast concrete of fiberglass bell liners instead. Fiberglass bell liners at Riverside N.C. were reported to cost $68 each. Several quotations for concrete bell liners indicate they cost approximately 70% of the cost for concrete boxes with lids.

Table 6-1 also includes reported values for FY 1978 of markers at the sample of 22 national cemeteries. They ranged from $46 to $87 and averaged $66. This represents the cost of upright markers. A study of marker costs in FY 1977 (Ref. 2.1) reported an average upright marker cost at that time of $54 and costs for flat markers ranging from 45% to 60% of the costs for upright markers.

Escalating the available data to December 1979, we estimate the current unit costs for liners furnished and placed and markers furnished to vary as follows:

Item	**Unit Costs**		
Liners (Furnished and placed)	**Min.**	**Max.**	**Avg.**
Concrete Box and Lid	$55	$115	$85
Concrete Bell	$40	$ 80	$60
Fiberglass Bell	$60	$ 90	$75
Markers (Furnished only)			
Upright Marble	$50	$ 95	$70
Flat Granite or Bronze	$25	$ 60	$45

6.4 Preplaced Double Depth Lawn Crypts

For the prototype depicted in Figures 5.5 through 5.7, constructed under ideal cut and fill conditions, we have estimated a current unit cost of $230 to $300 per double depth crypt, including backfill and seeding. A recent estimate made by the Veterans Administration in-house resulted in an average estimate of $250 per double depth crypt. There are adverse foundation conditons (such as high rock or steep slopes) and market conditions (suce as no nearby precasting facilities) that could cause the price per double depth crypt to be as high as $350.

Accordingly, allowing $50 per double depth crypt for a flat marker, the cost throughout the National Cemetery System for a double depth crypt installed plus a marker furnished is currently most likely to range from a minimum of $280 to a maximum of $400.

6.5 Garden Crypts and Columbarium Niches

For the prototype of garden crypts depicted in Figure 5.9 we have estimated a current unit cost of $400 to $550 per crypt, including special sitework costs. As with lawn crypts, there are adverse environmental, foundation and market conditions that could cause the price to rise $100 per crypt or more higher.

For the prototypes of free-standing columbaria walls depicted in Figure 5.12, we have estimated a current unit cost of $100 to $160 per niche, including special sitework costs. A recent analysis by the Veterans Administration of a somewhat similar columbaria scheme indicated a current unit cost of $140 per niche. Quotations we have received indicate that niches, depending on design conditions, may cost as much as $250 per niche and even more. Constructing a retaining wall of similar height to create a columbarium wall with niches added to the exposed face would raise these estimated costs by approximately $30 to $40 per niche.

For add-on columbaria, where the niches are being added to a stone clad building wall or retaining wall needed for another purpose, we have analyzed a scheme estimated several years ago at Willamette National Cemetery and another very recently at Calverton National Cemetery and have concluded the current range of unit costs for adding on niches will vary between $50 and $100 per niche—and under unusual circumstances perhaps as high as $150 per niche.

Summarizing, we estimate the current unit costs of construction throughout the National Cemetery System for above ground interment structures (including marker inscriptions, associated walks, parking space, reserved access and other special site work) to vary as follows:

		Current Unit Cost	
Interment Prototype Structure	**Unit**	**Min.**	**Max.**
Garden Crypts	Crypt	$400	$650
Freestanding Columbaria Walls	Niche	$100	$250
Retaining-type Columbaria Walls	Niche	$140	$280
Add-on Columbaria	Niche	$ 50	$150

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7 COSTS OF INGROUND INTERMENTS IN NATIONAL CEMETERIES

7.1 Selection of a Significant Sample

Inasmuch as the results of this study are principally intended to assist decision-making with relation to active cemeteries having a signficant annual interment rate—the cemeteries most likely to be in a position to consider alternative interment methods—our sample was generally restricted to cemeteries having more than 400 interments annually. This is equivalent to approximately 2 interments per day. At rates less than that, it was felt that efficiency would likely be too variable; however, several cemeteries at rates between 100 and 200 interments annually were included to see if they followed the pattern of larger cemeteries. The characteristics of the 22 cemeteries selected for detailed analysis are shown in Table 7-1. The annual interment rate in 1978 varied from 143 to 9,818, averaging 1,350 for the sample as a whole and 950 if the largest interment rate is left out of the sample.

7.2 Calculation of Interment Costs

The responses to the questionnaire, with some exceptions, were used to construct summaries of interment cost data. These costs did not include the costs of liners and markers which, under the terms of this study, are considered "construction costs". The following items were evaluated:

(1) Operations labor wages (interments and headstones)

(2) Overburden (benefits) on labor wages

(3) Outside contract costs

(4) Annual equipment costs

(5) Fuel and other equipment maintenance materials

(6) Materials used for grave establishment; such as, lumber, topsoil, seed, etc.

Those items were evaluated as follows:

(1) Considerable difficulty was found in evaluating item (1) directly from questionnaire responses because a large percentage of cemeteries, especially those with smaller interment rates, do not have separate operations and maintenance staffs. All staff members perform both functions. This difficutly was resolved by using the cumulative man hour reports for fiscal year (FY) 1978 for interment and headstone operations (Ref. 7.1). These were converted to man years at the rate of 1,760 productive man hours per man year (the average for the 22 cemeteries) and multiplied by the average annual interment salary.

(2) A uniform salary overburden rate of 11% was used to cover money-added benefits such as insurance and pension.

(3) The only outside contract cost recorded was related to contract grave digging. This was translated to interment man years and used to increase the cemetery's interment manpower.

(4) Annual equipment costs were obtained by having each cemetery list all interment and headstone equipment, its purchase price, and estimated useful life.

TABLE 7-1

Cemetery	Total Maintained Acres	Acres Developed in Gravesites	Total Annual Inground Interments
NY-1	364	326	9,817
MN-1	169	115	2,868
OR-3	94	85	2,153
MO-1	125	125	2,219
TX-3	63	63	1,614
CO-1	41	41	1,469
CA-1	162	150	1,174
TX-1	45	45	1,078
PR-1	90	35	770
TX-2	43	43	726
WI-1	42	34	648
TN-4	44	44	634
NM-1	21	21	607
HI-1	65	65	606
FL-1	31	31	547
CA-2	72	68	512
KS-1	36	36	516
TN-5	65	60	420
TN-1	120	77	416
CA-3	110	110	194
VA-2	17	12	195
TN-3	30	20	143
		Total	29,706
		Average	1,350
		Average, excluding NY-1	950

(5) In most cases, when fuel and equipment maintenance materials costs seemed incongruous, we contacted the cemetery director to review them.

(6) The reporting of other materials used to establish graves was reasonably straightforward.

The compilation of raw data on cost can be found in the Appendix. Table 7-2 indicates that the raw, unadjusted unit costs per interment varied from $70 to $181.

7.3 Variations in Average Salary Costs

In order to make the data collected applicable anywhere throughout the National Cemetery System, it was necessary to reduce unit costs to a national average wage basis so that they would be comparable in terms of man-hour productivity. This was necessary because wages were found to vary significantly, as may be seen in Table 7-3. In general, average operations wages (interments and headstones) almost always involving higher paid equipment operators, exceeded average maintenance wages, which often involved temporaries at minimum scale. The average 1978 interment salary was $14,400 and the average 1978 maintenance salary was $13,000.

In each category, a *cost index* was calculated—as the ratio of the average wage at each cemetery to the average wage of the entire group of cemeteries analyzed. The cost indices for operations and maintenance, listed in Table 7-3, range from 0.64 to 1.56. These indices were used to correct the raw unit costs of interment and maintenance to a national average wage basis.

7.4 Correction for Topsoil Purchases

There are certain quantifiable factors that unduly and randomly influence unit costs. The raw data was corrected for each influence through the use of a correction factor.

The need to purchase topsoil to spread over new gravesites is an accidental site characteristic that unduly increases interment unit costs. Raw interment unit costs were divided by a topsoil correction factor:

$$\text{Topsoil Factor} = \frac{\text{Annual Cost of Interments}}{\text{Annual Cost of Interments} - \text{Cost of Topsoil Purchased}}$$

7.5 Adjusted Interment Unit Costs

Table 7-4 lists for each cemetery the raw unit cost for interments; the correction factors applied to it; the adjusted unit cost; and its rank.

A number of environmental factors might be expected to influence interment costs: type of soil and difficulty of excavating; slope of terrain; inclement weather; etc. As discussed later, none seemed to show sufficiently strong correlation with the ranking of unit costs. Accordingly, it was decided to revert to a basic factor that must have strong correlation with unit costs: the number of interment employees per annual interment. The number of interment employees was taken to be equal to the number of man-years the records showed had been devoted in 1978 to interment and headstone operations. The inversion of that, the number of annual interments per interment employee, is customarily used as a measure of industry efficiency. It was felt that in the case of an operating cemetery, the primary potential user of a study such as this, its annual

TABLE 7-2

Cemetery	Unit Cost per Interments (Unadjusted)	Rank
CA-1	$181	1
OR-3	172	2
HI-1	161	3
CA-3	158	4
TN-5	155	5
CO-1	145	6
WI-1	142	7
TN-1	135	8
MO-1	128	9
NY-1	124	10
NM-1	117	11
TX-3	112	12
VA-2	108	13
CA-2	105	14
MN-1	102	15
PR-1	102	16
FL-1	100	17
TX-2	96	18
TN-4	87	19
TN-3	86	20
TX-1	73	21
KS-1	70	22
	Average $120	

TABLE 7-3

Cemetery	Average Interment Salary	Interment Cost Index	Average Maintenance Salary	Maintenance Cost Index
CA-1	$ 15,184	1.04	$ 15,395	1.18
NM-1	15,153	1.03	13,478	1.03
OR-3	17,252	1.18	15,366	1.18
NY-1	14,743	1.02	12,205	0.93
TX-3	12,897	0.88	11,833	0.91
TX-1	12,363	0.84	10,984	0.84
CO-1	16,620	1.13	15,088	1.15
CA-3	14,300	0.99	16,438	1.26
TN-4	13,009	0.87	10,814	0.83
KS-1	15,410	1.05	15,317	1.17
MN-1	16,922	1.15	14,900	1.14
CA-2	14,533	0.99	11,407	0.87
MO-1	15,445	1.05	13,870	1.06
TX-2	13,700	0.93	11,888	0.91
VA-2	12,000	0.82	11,200	0.86
WI-1	15,998	1.09	11,621	0.89
FL-1	14,398	0.98	13,592	1.04
TN-3	10,444	0.71	9,836	0.75
TN-5	11,603	0.79	11,090	0.85
HI-1	21,052	1.44	20,326	1.56
TN-1	14,679	1.02	11,105	0.85
PR-1	9,157	0.64	9,157	0.70
Average	$ 14,400	Average	$ 13,000	

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TABLE 7-4

Cemetery	Cost of Interments/ Gravesite (Unadjusted)	Interment Cost Index	Topsoil Factor	Adjusted Cost of Interments/ Gravesite	Rank
TN-5	155	0.79	1.07	183	1
PR-1	102	0.64	1.00	159	2
CA-3	158	0.99	1.05	152	3
OR-3	172	1.18	1.00	146	4
VA-2	108	0.82	1.00	132	5
TN-1	135	1.02	1.00	132	6
CO-1	145	1.13	1.00	128	7
TX-3	112	0.88	1.01	126	8
CA-1	181	1.04	1.39	125	9
WI-1	142	1.09	1.04	125	10
MO-1	128	1.05	1.00	122	11
TN-3	86	0.71	1.00	121	12
NY-1	124	1.02	1.06	115	13
NM-1	117	1.03	1.00	114	14
HI-1	161	1.44	1.00	112	15
CA-2	105	0.99	1.02	104	16
TX-2	96	0.93	1.00	103	17
FL-1	100	0.98	1.00	102	18
TN-4	87	0.87	1.00	100	19
MN-1	102	1.15	1.00	89	20
TX-1	73	0.84	1.03	84	21
KS-1	70	1.05	1.00	67	22
			Average	$120	

Note: $\text{Adjusted Cost} = \dfrac{\text{Unadjusted Cost}}{\text{Interment Cost Index} \times \text{Topsoil Factor}}$

TABLE 7-5

Cemetery	No. of Interment Employees/ Annual Interment	*Interment Productivity Rate* Annual Interments/ Interment Employee*
KS-1	.0030	338
TX-1	.0037	270
MN-1	.0044	227
TN-4	.0047	211
CA-1	.0051	196
FL-1	.0055	182
TX-2	.0055	182
NM-1	.0058	173
CA-2	.0059	171
TN-3	.0059	168
TN-1	.0060	166
WI-1	.0062	162
TX-3	.0062	162
VA-2	.0062	161
NY-1	.0064	156
CA-3	.0064	155
HI-1	.0066	152
MO-1	.0068	148
CO-1	.0068	148
OR-3	.0079	127
PR-1	.0084	118
TN-5	.0100	99
Average	.0060	176

*Or Annual Interments/Man-Year

interments/employee ratio would be known even if the myriad influences determining that ratio could not be readily quantified. These ratios, which are in fact interment productivity rates, are listed in Table 7-5. The number of interments per interment employee varied from 99 to 338 and averaged 176. The average is equivalent to 10 manhours of productive time per interment and compares with the frequently expressed private sector goal of 8 to 9 man hours per interment—although the impact of headstone operations on productivity is judged to be greater in national cemeteries and therefore more man hours per interment should be expected.

Figure 7.1 is a plot of Adjusted Interment Unit Costs versus the Number of Interment Employees/Annual Interment. Although there is considerable scatter in the data, a significantly strong correlation is evident. The scatter is primarily a result of inaccuracies in reporting and variations in equipment and material costs.

The data plotted in Figure 7.1 have been corrected for regional variations in annual salary and represent national average costs when no topsoil has be to purchased. A reasonable fit to the data is described by the simple equation:

$Io =$ \$19,500/PI

where $Io =$ The average adjusted unit cost of interments (in dollars)

$PI =$ Interment Productivity Rate – the number of annual interments per interment employee (or per man-year)

This formula represents the national average FY 1978 relationship between interment unit costs and productivity rates. Unit costs may be extrapolated into the future with a simple escalation index, such as the ratio of future average salaries to the FY 1978 national average salary, provided that the relationship between the components (wages, benefits, materials and equipment) remains proportionally constant. In time those relationships could change; similarly, in time the average productivity of the National Cemetery System could change. Accordingly, this basic data should be reexamined every five years.

7.6 Productivity and Management

Interment and maintenance costs vary inversely with the increase of productivity rates, expressed in terms of interments per employee and maintained acres per employee. The more fundamental question we sought to answer through analysis of questionnaire responses and personal observations is: What causes a specific cemetery to have a specific productivity rate?

There are several general management questions, the answers to which we believe have a significant impact on productivity rates but that we are not able to quantify:

- How well is this cemetery maintained when compared to other cemeteries?
- Is the cemetery understaffed or overstaffed?
- Are the work procedures that are enforced designed to achieve reasonable productivity?
- Is this cemetery, because of competing market conditions in its area, able to keep an experienced staff?
- Is adequate use of larger, more efficient machines being made, or is everything being done with small machines and by hand?
- Is adequate supervision of the work force being provided?

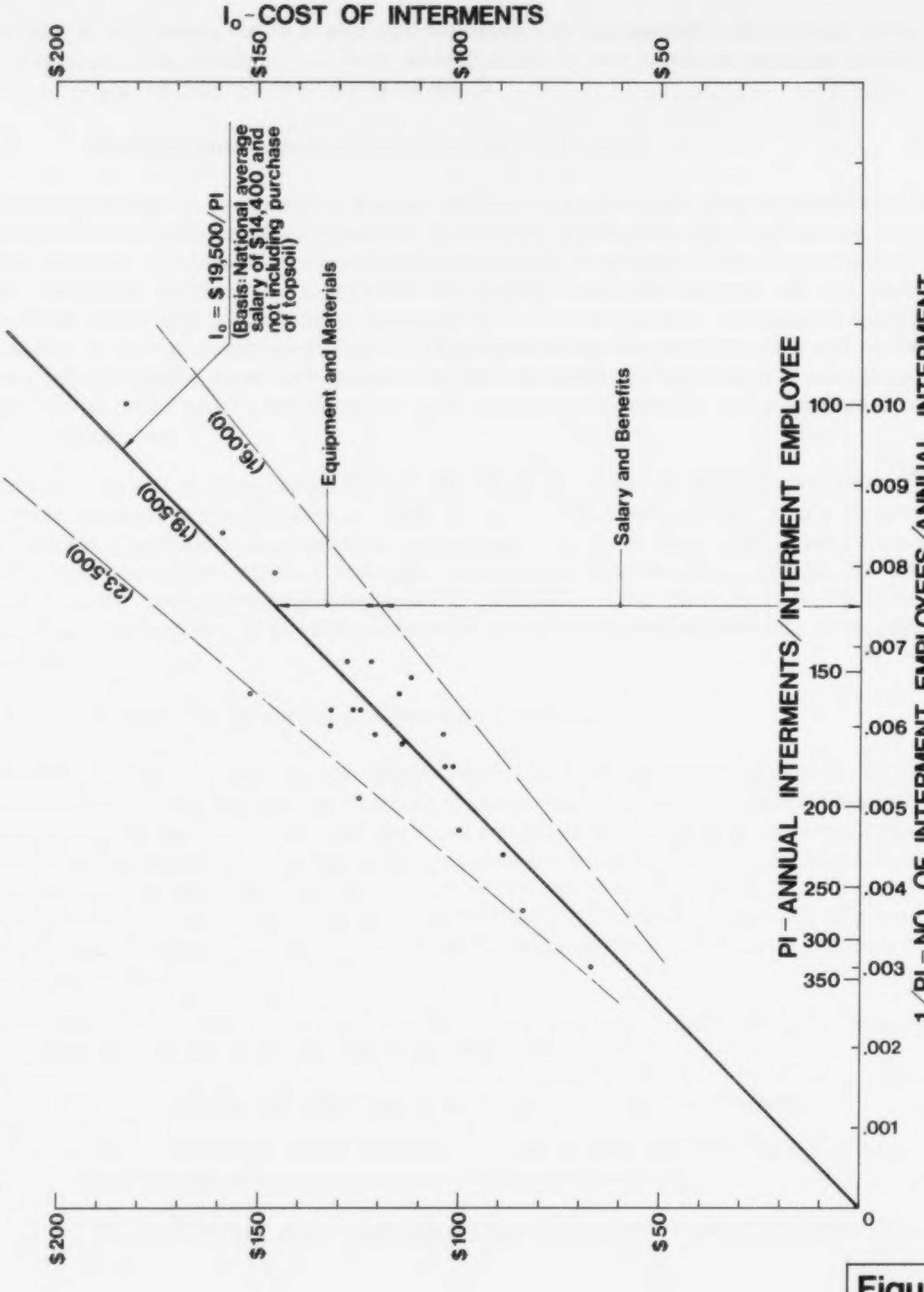
I₀-COST OF INTERMENTS
$200
$150
$100
$50
0
I₀ = $19,500/PI
(Basis: National average salary of $14,400 and not including purchase of topsoil)
Equipment and Materials
Salary and Benefits
(15,000)
(19,500)
(23,500)
100
150
200
250
300
350
.010
.009
.008
.007
.006
.005
.004
.003
.002
.001
PI-ANNUAL INTERMENTS/INTERMENT EMPLOYEE
1/PI-NO. OF INTERMENT EMPLOYEES/ANNUAL INTERMENT

Figure 7.1

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In a sense, these questions are a measure of the cemetery director's approach to management. Of course the longer his tenure at a particular cemetery, the better he ought to be able to tailor his management procedures to that cemetery's unique requirements. We believe management techniques play a more important role in determining the productivity rate with respect to maintenance but a less important role with respect to interments, where other factors seem more important.

While it is impossible for us to evaluate the impact of management techniques within the scope of this study, it is possible to attempt an evaluation of environmental and operational influences on unit costs for interments and maintenance.

7.7 Environmental Influences on Interment Unit Costs

When a gravesite is excavated in a given cemetery the procedure may be easier or more difficult than in another cemetery for a number of environmental reasons. Climatic factors, such as the annual amounts of rainfall and snowfall and the severity of winters, affect the number of man hours per interment. Productivity is affected by geotechnical factors such as the shallowness of bedrock below the surface, the closeness of the water table to the ground surface, and the stability of the soil being excavated. Physiographical factors, such as the slope of the land to be used for interments, have their impact. Cemeteries whose average slope of land exceeds ten percent will be faced with higher interment unit costs than a cemetery whose average gradient is less than five per cent.

Combinations of environmental factors can have an influence greater than those factors considered separately. For instance, a heavy annual rainfall combined with heavy clays can produce conditions that inhibit operations for weeks at a time. In the same way, heavy rainfall combined with soils which prevent good drainage can increase the interment time by the extra effort to remove water from the excavations. Another combination that can lead to higher interment costs are long periods of rain or snow in cemeteries with relatively steep slopes or with collapsible soils or both.

7.8 Operations Influences on Interment Unit Costs

The annual interment rate has the largest influence on the number of personnel devoted to interment and headstone operations. In a recent study made by the Veterans Administration (Ref. 7.2) the average number of annual interments per employee for the national cemetery system was 159. Based on the sample of 22 larger active national cemeteries examined in this study the average number of interments per employee was 176, but varied widely. Other factors being equal, one would expect productivity to increase as the daily and annual interment rate increases. The percentage of reopeners may also affect costs because of the greater time and care that must be taken with them.

A number of other operational factors influence the costs of interments in a minor way but are very difficult to evaluate in any significant manner:

(1) Costs decrease slightly as the depth of grave decreases.

(2) Interment labor costs are reduced slightly when no permanent liner has to be placed.

(3) The type of liner and the method by which it is placed can also affect unit cost.

For example, a fiberglass bell-type liner is less expensive to place than a concrete box liner with a lid.

(4) The efficiency of equipment available for interments will have an effect on interment costs.

(5) The final costs of an interment operation after initial backfilling involve the "dressing up" of the ground surface and the placing of the permanent marker. The costs vary from one national cemetery to another for a number of reasons. Some cemeteries place topsoil as the top three or four inches of soil; some strip, store and replace topsoil; some purchase topsoil; some manufacture their own topsoil; and, some use none at all. The same kind of variation in costs results when a cemetery is faced with the decision to buy new sod; replace old sod; use seed or sprigs; or provide no surface treatment at all. In some areas of the South, carpet grass or other fast growing types will spread quickly and naturally so that reseeding or sodding is unnecessary.

7.9 Ranking of Interment Unit Costs and Environmental/Operations Factors

Table 7-6 compares the influence of the following factors on the ranking of interment unit costs:

- Low annual interment rate (less than 500)
- The presence of significant quantities of rock or hardpan excavation
- High percentage of reopeners (over 25%)
- Steeply sloping ground (2/3 or more over 5% slope)
- Severity of winter (February average temperature below 30°F.)
- High annual precipitation (over 50" rainfall or 40" snowfall)

A significant correlation should exist if one of these factors, all presumed to have a negative influence, appears predominantly opposite the higher unit costs ranked 1 through 11. As may be seen the only correlations that appear reasonably significant are between higher unit costs and (1) low annual interment rates, (2) the presence of rock at grave excavation levels, and (3) sloping ground. The other factors, which seemingly should have relevance, apparently have none or very little.

By correlating Table 7-5 and Table 7-6, the following very general guidlines are indicated:

(1) If a cemetery has less than 500 annual interments and encounters a significant quantity of rock its productivity rate will probably lie between 100 and 160 interments/man-year.

(2) If a cemetery has more than 500 annual interments, encounters no rock and has less than 2/3 of its ground under 5% slope, its productivity rate will probably lie between 180 and 300 interments/man-year.

TABLE 7-6

Ranking of Interment Unit Costs and Environmental/Operations Factors

Cemetery	Unit Cost Rank	Low (1) Annual Interments	Rock (2)	High (3) % Reopeners	Sloping Ground (4)	Severe Winters (5)	High Precipitation (6)
TN-5	1	●	●				●
PR-1	2				●		●
CA-3	3	●	●	●			
OR-3	4		●		●		●
VA-2	5	●	●				
TN-1	6	●	●		●		
CO-1	7					●	●
TX-3	8				●		
CA-1	9			●	●		
WI-1	10					●	●
MO-1	11						
TN-3	12	●			●		
NY-1	13			●		●	
NM-1	14				●	●	
HI-1	15		●				
CA-2	16			●	●		
TX-2	17		●				
FL-1	18						●
TN-4	19						●
MN-1	20			●		●	●
TX-1	21						
KS-1	22						

(1) Less than 500 interments per year
(2) Rock or hard pan in 15% or more of grave excavations
(3) More than 25% of interments
(4) At least ⅔ of cemetery over 5% slope
(5) Average temperature in February 30° F. or below
(6) More than 50" rainfall or 40" snowfall annually

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8 COSTS OF MAINTENANCE IN NATIONAL CEMETERIES

8.1 Calculation of Maintenance Costs

The same 22 sample cemeteries were used to calculate maintenance costs per acre per year. The following items were evaluated:

(1) Maintenance labor wages
(2) Overburden (benefits) on labor wages
(3) Outside contract costs
(4) Annual equipment costs
(5) Fuel and other equipment maintenance materials
(6) Materials used for maintenance of grounds

Difficulties encountered with responses related to maintenance costs were resolved in the same manner as discussed in Chapter 7 for interment costs.

Inasmuch as most questionnaire respondents felt that 40% to 70% of their lawn care effort was expended in trimming around markers, it is probably safe to say that at least twice as much effort is required to maintain an acre already developed in gravesites with markers as to maintain an undeveloped acre. Accordingly, total maintained acres were corrected to adjusted maintained acres by counting each undeveloped but maintained acre as a half-acre.

Adjusted Maintained Acres = Developed acres + 0.50 × (Total maintained acres − developed acres).

The sum of cost items (1) through (6) was taken as the annual cost of maintenance. That sum divided by the total number of adjusted maintained acres of cemetery was taken as the raw cost of maintenance per maintained acre. Compilations of the raw data may be found in the Appendix. These raw data are presented in Table 8-1. The cost of maintenance per adjusted acre ranged from $1,079 to $9,318 and averaged $3,688.

Maintained acres were used as a unit of measurement instead of gravesites because the density of gravesites per acre was found to vary throughout the sample cemeteries from less than 300 per acre to more than 700 per acre. The acre is also a more direct measure of what the money is being spent to maintain.

8.2 Correction for Sinkage Repair

Sinkage repair costs related to grave collapses and other settlements influence maintenance unit costs in significant measure. They are strongly dependent on whether or not durable liners have been used in the past. In order to make all cemeteries more comparable with respect to the basic effort of maintenance, a sinkage correction factor was applied to raw unit cost data for FY 1978.

$$\text{Raw Sinkage Factor} = \frac{\text{Total No. Maintenance Man Hours}}{\text{Total No. Maintenance Man Hours} - \text{Man Hours Repairing Sinkages}}$$

The sinkage factor is a fairly direct measure of the extra maintenance effort required, above normal maintenance, to counteract the settlements related to casket or non-durable liner collapses. It also partially reflects the quality of tamping grave backfill and the variations of soil conditions. We have maximized the values for FY 1978 by including all the work details that could be related

TABLE 8-1

Cemetery	Cost of Maintenance/Adjusted Acre	Rank
HI-1	$ 9,318	1
NM-1	7,370	2
CA-1	5,642	3
OR-3	5,179	4
KS-1	4,826	5
CA-3	4,533	6
CO-1	4,463	7
TX-3	3,997	8
FL-1	3,487	9
WI-1	3,398	10
CA-2	3,304	11
TN-4	3,132	12
NY-1	3,117	13
MN-1	3,020	14
VA-2	2,926	15
TN-3	2,485	16
TX-1	2,396	17
MO-1	2,387	18
TX-2	2,365	19
TN-5	1,256	20
TN-1	1,241	21
PR-1	1,079	22
	Average $ 3,688	

TABLE 8-2

Cemetery	Raw Sinkage Factor	Total Sinkages ÷ Sinkages Repaired	Sinkage Factor
NM-1	1.10	1.2	1.12
HI-1	1.15	1.3	1.20
CA-1	1.05	1.1	1.06
KS-1	1.09	1.0	1.09
CA-2	1.07	1.0	1.07
OR-3	1.23	1.0	1.23
TX-3	1.34	1.0	1.34
CA-3	1.11	1.0	1.11
CO-1	1.28	1.0	1.28
TN-3	1.11	1.0	1.11
VA-2	1.14	1.2	1.17
TN-4	1.38	1.0	1.37
NY-1	1.23	5.3	2.22
WI-1	1.40	1.0	1.40
TX-1	1.09	1.9	1.17
MN-1	1.11	2.3	1.25
TX-2	1.19	1.5	1.28
FL-1	1.63	1.0	1.63
MO-1	1.25	1.0	1.25
PR-1	1.02	1.0	1.02
TN-5	1.06	1.1	1.07
TN-1	1.14	2.0	1.27
	Average 1.19		Average 1.26

to sinkage. These included:

- Raising and realigning headstones
- Refilling graves
- Reseeding graves
- Resodding graves

A compilation of raw sinkage factors for the 22 sample cemeteries investigated can be found in Table 8-2. They varied from 1.02 to 1.67, averaging 1.20. Although a few of the study's questionnaires provided the historical data requested on the past use of liners, most directors either misinterpreted the request or were unable to estimate the extent to which privately furnished liners had been used in the past. As a result, it was not possible to establish a correlation between the sinkage factor and, for instance, the percentage of developed gravesites without liners. What is known is that there is such a correlation but that other factors such as tamping, casket materials, groundwater and soil conditions can and do have a masking influence.

The raw sinkage factor does not reveal the true picture, however. It reveals the extent of sinkage repair work that was done in FY 1978 but does not reveal the extent of sinkage repair work that was left undone due to lack of available manpower. A more revealing sinkage factor is expressed as follows:

$$\text{Sinkage Factor} = \frac{\text{Total No. of Maintenance Man Hours}}{\text{Total No. Man Hours} - \text{Man Hours required to repair all sinkages}}$$

Such data as the "man hours required to repair all sinkages" is not readily available. We approximated it by multiplying the man hours devoted to repairing sinkages by the ratio of planned units of gravesite refilling to actual units of gravesite filling reported for FY 1978 (Ref. 7.1). This ratio is shown in Table 8-2 and leads to the following modification:

$$\text{Manhours required to repair all sinkages} = \text{Manhours repairing sinkages} \times \frac{\text{Total sinkage repairs planned}}{\text{Actual sinkages repaired}}$$

For any cemetery where the actual sinkage repairs equalled or exceeded planned sinkage repairs, a modifying ratio of 1.0 was used. The additional sinkage manhours calculated were assumed to increase both "Total No. of Maintenance Manhours" and "Manhours required to repair all sinkages" in calculating the modified sinkage factor. The sinkage factors thus developed varied from 1.02 to 2.22 and averaged 1.26. Thirteen of the 22 sample cemeteries were able to repair more than the number of sinkages planned for repair.

The maximum sinkage factor in a cemetery that repaired all the sinkage it had planned to repair was recorded at Barrancas in Florida where liners are not provided (but a certain percentage are privately provided) and the groundwater is high. The sinkage factor at Long Island in New York was extremely high, despite sandy subsoil and deep groundwater, because a very high percentage of the several hundred thousand older gravesites contain no liners and because, as a result of their extremely high interment rate, they had been unable to divert manpower for sinkage repair. In our opinion, their sinkage factor would be no higher than at Barrancas if sinkage repair work could be taken care of annually. On the other hand, Puerto Rico, which does not use liners, reports almost no sinkage problems. It is reported that practically all caskets there are metal, which they report tend to have a relatively long life, and that graves are dug to snug dimensions and are carefully tamped. This care with interments may tend to explain their relatively high number of man hours per interment.

One of the interment alternatives to be considered is inground interment without a durable liner. Under those conditions and the predominant use of wood caskets or liners, testimony gathered during this study indicates there will be the usual initial settlements, typically followed by a minor collapse in 4 to 7 years, a major collapse in 10 to 12 years and minor readjustment sinkages for many years. In a cemetery with few or no liners in place we believe the existing sinkage factor is an adequate and relatively direct measure of the long range annual cost that will be incurred because no liners are being used. In a sense it is also a composite measure of the impact of soil types, groundwater, tamping methods, etc., on the amount of sinkage repair effort required. In a cemetery that has been using durable liners for several years, the collapses that normally occur in the first twelve years will not occur and the overall sinkage factor that will properly reflect the cost of not having liners in that cemetery will be greater than the sinkage factor currently being experienced.

8.3 Adjusted Maintenance Unit Costs

Table 8-3 lists for each of the 22 sample cemeteries its raw cost of maintenance per adjusted maintained acre; the cost index converting it to a national average cost; its applicable raw sinkage correction factor; the adjusted cost of maintenance per acre; and its rank.

Many environmental factors might be expected to influence maintenance costs: type of soil; amount of rainfall; length of growing season; ground slopes, etc. Operations factors that might be expected to influence unit costs are the size of the cemetery being maintained; the use of upright vs. flat markers; the percentage of reopeners; reliance on equipment vs. manpower, etc. None seemed to show sufficiently strong correlation with the ranking of unit costs.

Accordingly, it was decided to revert to a basic factor that must have strong correlation with unit costs: the number of maintenance employees per adjusted maintained acre. The inversion of that, the number of maintained acres per maintenance employee, is customarily used as a measure of industry efficiency. Again it was felt that, in the case of an operating cemetery, its maintained acres/employee ratio would be known. These data are listed in Table 8-4.

The number of adjusted maintained acres per maintenance employee ranged from 2.4 to 14.9 and averaged 6.8 acres per employee. These productivity rates reflect the effort required to perform basic maintenance work, not including sinkage repair, per adjusted maintained acre, as defined previously.

Figure 8.1 is a plot of Adjusted Maintenance Unit Costs per Year versus the Number of Maintenance Employees per Adjusted Maintained Acre. There is some scatter but fairly strong correlation. The data plotted in Figure 8.1 have been corrected for regional variations in annual salary and represent average costs of maintenance *excluding* the reported costs of repairing grave sinkages. A reasonable fit to the data is described by the simple equation:

$$Mo = \$17{,}000/PM$$

where Mo = The average adjusted cost of maintenance per adjusted maintained acre (in dollars)

PM = Maintenance Productivity Rate—the number of adjusted maintained acres per maintenance employee, or man-year (in which the number of employees has been reduced by the number of man years devoted to sinkage repair).

As discussed in Section 7.5 regarding interments, the basic data for maintenance unit costs should be reexamined every five years.

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TABLE 3-3

Cemetery	Cost of Maintenance/ Adjusted Acre	Maintenance Cost Index	Raw Sinkage Factor	Adjusted Cost of Maintenance/ Acre	Rank
NM-1	7,370	1.03	1.10	6,505	1
HI-1	9,318	1.56	1.15	5,194	2
CA-1	5,642	1.18	1.05	4,554	3
KS-1	4,826	1.17	1.09	3,784	4
CA-2	3,304	0.87	1.07	3,549	5
OR-3	5,179	1.18	1.23	3,568	6
TX-3	3,997	0.91	1.34	3,278	7
CA-3	4,533	1.26	1.11	3,241	8
CO-1	4,463	1.15	1.28	3,032	9
TN-3	2,485	0.75	1.11	2,985	10
VA-2	2,926	0.86	1.14	2,984	11
TN-4	3,132	0.83	1.38	2,734	12
WI-1	3,398	0.89	1.40	2,727	13
NY-1	3,117	0.93	1.23	2,725	14
TX-1	2,396	0.84	1.09	2,617	15
MN-1	3,020	1.14	1.11	2,387	16
TX-2	2,365	0.91	1.19	2,184	17
FL-1	3,487	1.04	1.63	2,057	18
MO-1	2,387	1.06	1.25	1,802	19
PR-1	1,079	0.70	1.02	1,511	20
TN-5	1,256	0.85	1.06	1,394	21
TN-1	1,241	0.85	1.14	1,281	22
		Average	1.19	$3,004	

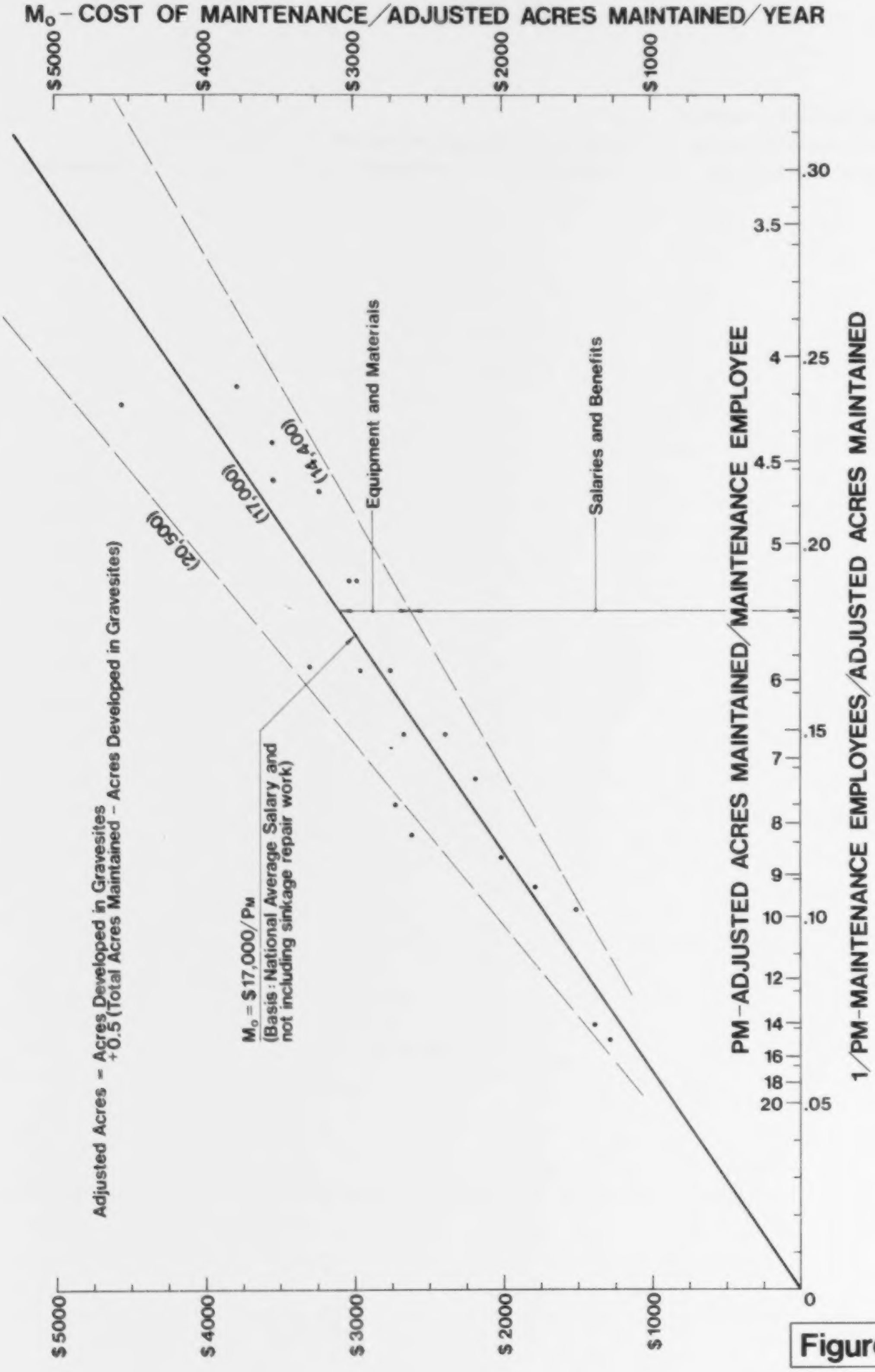
M₀ - COST OF MAINTENANCE/ADJUSTED ACRES MAINTAINED/YEAR
$5000
$4000
$3000
$2000
$1000
PM-ADJUSTED ACRES MAINTAINED/MAINTENANCE EMPLOYEE
1/PM-MAINTENANCE EMPLOYEES/ADJUSTED ACRES MAINTAINED
3.5
4
4.5
5
6
7
8
9
10
12
14
16
18
20
.30
.25
.20
.15
.10
.05
0
Equipment and Materials
Salaries and Benefits
(14,400)
(17,000)
(20,500)
Adjusted Acres = Acres Developed in Gravesites +0.5 (Total Acres Maintained - Acres Developed in Gravesites)
M₀ = $17,000/PM
(Basis: National Average Salary and not including sinkage repair work)

Figure 8.1

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TABLE 8-4

Cemetery	No. of Maintenance Employees*/ Adjusted Acres Maintained	***Maintenance Productivity Rate*** Adjusted Acres Maintained/ Maintenance Employee*
TN-1	.067	14.9
TN-5	.071	14.0
PR-1	.102	9.8
MO-1	.108	9.3
FL-1	.116	8.6
TX-1	.122	8.2
NY-1	.130	7.7
TX-2	.137	7.3
WI-1	.149	6.7
MN-1	.149	6.7
VA-2	.166	6.0
TN-4	.166	6.0
TX-3	.167	6.0
CO-1	.190	5.3
TN-3	.190	5.3
CA-3	.214	4.7
OR-3	.217	4.6
CA-2	.227	4.4
CA-1	.237	4.2
KS-1	.242	4.1
HI-1	.348	2.9
NM-1	.410	2.4
	Average 0.178	6.8

*Or Man-year(s), by the number of man-years devoted to the repair of sinkages

8.4 Environmental Influences on Maintenance Unit Costs

Environmental influences on maintenance operations are essentially the same factors that affect interment operations. One other that could have a significant influence on the cost of maintenance is the duration of periods of drought. Sections of the arid west are prone to long droughts and the cost of maintenance on lawns and planting will be understandably higher. The length of growing season can also increase the costs of maintenance. A long growing season means little or no costs involved with winter maintenance but more importantly it means longer periods to mow and maintain grass, and most probably more frequent mowing. Another minor cost in maintenance which some cemeteries face while others do not is the raking of leaves. Those cemeteries in the northern regions with large numbers of deciduous trees planted in the gravesite areas have the added costs not only of leaf removal but additional tree care as well. Sources of irrigation water can also affect costs in a minor way. Cemeteries with their own sources of water, such as rivers, lakes, or deep wells, generally have lower water costs than the cemeteries having to purchase water.

8.5 Operations Influences on Maintenance Unit Costs

The number of acres developed as gravesites and the number of total acres to be maintained directly affects the number of maintenance employees. The productivity rate for the sample of cemeteries studied was 6.8 acres per employee average but varied widely. We could not detect any significant relationship between productivity and the number of maintained acres.

One would expect that the amount of interment activity might influence maintenance problems because of the transportation of mud and rutting it causes, so that it appears reasonable that the cost of maintenance might be greater in cemeteries having high annual interment rates. A similar impact should be expected from a high percentage of reopeners as previously completed areas are continually disturbed.

One operations factor that clearly has a very important impact on maintenance costs is the decision that is usually made to enter upon major rehabilitation in the years immediately preceding and following the closing of an active cemetery. Staffs are usually increased during those years, especially using summer temporaries, and the costs of maintenance per acre usually rise measurably.

8.6 Ranking of Maintenance Unit Costs and Environmental/Operations Factors

Table 8-5 compares the influence of the following factors on the ranking of maintenance unit costs:

- High annual interment rate (over 1,000)
- Subject to drought (less than 1" rainfall/month for more than 20% of year) — Source: Ref. 8.1
- High percentage of reopeners (over 25%)
- Long growing season (more than 10 months)
- High precipitation (more than 50" rainfall or 40" snowfall)
- Major rehabilitation (during closing years)

A significant correlation should exist if one of these factors, all presumed to have a negative in-

TABLE 8-5

Ranking of Maintenance Unit Costs and Environmental/Operations Factors

Cemetery	Unit Cost Rank	High Annual Interments (1)	Subject to Drought (2)	High % Reopeners (3)	Long Growing Season (4)	High Precipitation (5)	Major Rehabilitation (6)
HI-1	1				●		
NM-1	2		●				
CA-1	3	●	●	●	●		●
OR-3	4	●				●	
KS-1	5		●				
CA-3	6		●	●	●		
CO-1	7	●	●			●	
TX-3	8	●					
FL-1	9					●	
WI-1	10					●	●
CA-2	11		●	●			
TN-4	12					●	
NY-1	13	●		●			●
MN-1	14	●	●	●		●	
VA-2	15						
TN-3	16						
TX-1	17	●					
MO-1	18	●					
TX-2	19		●				
TN-5	20						
TN-1	21						
PR-1	22				●	●	

(1) Over 1,000 interments per year
(2) Less than 1" rainfall/month over 20% or more of year
(3) More than 25% of interments
(4) More than 10 months
(5) More than 50" rainfall or 40" snowfall annually
(6) Either major landscape contract or build up of manpower

fluence, appears predominantly opposite the highest unit costs ranked 1 through 11. There does not appear to be a reasonably significant correlation between maintenance unit costs and high annual interments. All of the other factors tend to group in the upper half of the table, indicating some significance. By correlating Table 8-5 with Table 8-4, only the most general guidelines are suggested:

(1) If a cemetery suffers from severe drought conditions or intense rainfall (especially if coupled with clay soils) and especially if it is undertaking a major rehabilitation program or has more than 25% reopeners, it is highly likely to have a productivity rate lower than average, that is between 3 and 7 acres/man-year. If such a cemetery also has a growing season of 10 months or more it is likely to have a productivity rate between 3 and 5 acres/man-year.

(2) If a cemetery has less than 25% reopeners, is not undergoing major rehabilitation, and does not suffer from severe drought or intense rainfall, it is likely to have a productivity rate between 7 and 14 acres/man-year.

As previously stated, we believe that the wide spread of maintenance productivity rates is, in addition to the factors considered here, significantly affected by the relative quality of maintenance achieved and by management techniques. A test was made to see if those cemeteries showing high interment unit costs would show low maintenance unit costs and vice versa. If so, this would tend to indicate the influence of management in assigning personnel and help explain some of the wide variations in productivity encountered. The interment unit cost ranking and maintenance unit cost ranking of each of the 22 sample cemeteries were added together. If emphasis were merely being shifted from interment to maintenance, and vice versa, most cemeteries would tend towards the average ranking sum of 23 (22 + 1, 21 + 2, 20 + 3, etc.) rather than toward the possible extremes of 2 (1 + 1) and 44 (22 + 22). The ranking sums actually varied between 8 and 38. This indicates that some cemeteries have very high interment costs and very high maintenance costs and, conversely, that other cemeteries have very low interment costs and very low maintenance costs. It further indicates that environmental and operations factors must be the most important influences affecting costs, not administration emphasis. Such a test can not, however, detect the essential influence of management on productivity or the quality of maintenance found acceptable by management.

9 ESTIMATED COSTS OF INTERMENTS AND MAINTENANCE FOR ALTERNATIVE METHODS

The estimated costs of interments and maintenance that would be incurred by the National Cemetery System in relation to alternative methods of interment, were they to be adopted, were developed for the most part from observations made in the private sector.

9.1 Productivity Rates

It was possible to deduce the productivity rates for interments and maintenance for sample national cemeteries from the data gathered on inground burials. By and large the interment data constitutes the productivity for interring in 5'x10'x7' deep gravesites, the most prevalent method in use during FY 1978. There are undoubtedly some productivity differences between 6'x10'x5' deep gravesites and 5'x10'x7' deep gravesites, but none of the data gathered in this study allows us to compare two different grave depths under identical environmental conditions. In any event, observations of the interment process in numerous cemeteries throughout the country indicate that the actual time consumed in excavating and backfilling graves is not the most critical task determining the number of manhours per interment. Far more important in most cemeteries is the span of time which must be devoted to committal services. Even in the cemeteries with the largest interment rates, it did not appear that reducing the excavation time per grave by several minutes would in any way reduce the total manhours devoted to interments. Accordingly, for the purposes of economic comparison, all inground interment methods involving the excavation of a 5 ft. deep or 7 ft. deep grave, regardless of area, will be assumed to be adequately represented by the interment productivity rates for 5'x10'x7' deep gravesites—as reflected by the data collected for this study.

Observations of preplaced lawn crypt operations in the private sector and discussions with operators of such systems indicate that a basic crew of 3 using mechanized lowering equipment plus the equivalent of 1½ backup men handling caskets, tamping, replacing sod, etc. can handle up to 10 interments per day. This is equivalent to 450 interments per man-year and implies an annual interment rate of 2,000 if the crew were employed full time on interment operations and headstone operations. When the annual interment rate is less than 2,000, the productivity rate will tend to suffer somewhat as the crew shifts back and forth between interment and maintenance operations. Accordingly, for the purposes of economic comparison, we have assigned productivity rates of 350 interments/man-year at an annual interment rate of 400 or less varying to 450 interments/man-year at annual interment rates of 2,000 or greater. Linear interpolation may be used for interment rates between 400 and 2,000.

Similar observations of garden crypt operations in the private sector indicate that a basic crew of 2 using mechanized lifting equipment can handle up to 10 interments per day. This is equivalent to 1,000 interments per year per employee and implies an annual interment rate of 2,000 if the crew were engaged full time on interments. Accordingly, for the purposes of economic comparison, we have assigned productivity rates of 800 interments/man-year at an annual interment rate of 400 or less varying to 1,000 interments/man-year at an annual interment rate of 2,000 or greater.

Observations and testimony concerning the inground interment of cremains indicates that it takes approximately 1.5 man hours to excavate, place the container, backfill, repair the surface and set the marker. This is equivalent to 1,200 interments/man-year. Similarly, in connection with above-ground interment in a niche, it takes approximately 1.0 man hours to open the niche, install the urn or container, close the niche and later place the inscription—equivalent to 1,800 interments/man-year.

It was found that the private sector did not keep or would not divulge any records with respect to their productivity in maintaining above-ground crypts and niches. Discussions held during the course of this study and personal observations make it clear, however, that the maintenance effort is considerably less than for inground interments. Clearly, depending on weather and the attitude of the cemetery director, these costs can be reduced to virtually nothing. We estimated, however, that a maintenance employee working conscientiously to keep the faces of the structures clean and the immediate area presentable would be able, full-time, to handle at least two acres containing garden crypts or niches developed to typical private sector densities which would translate to 6,000 crypts and 9,000 niches. For the purpose of economic comparison, these productivity rates correspond to unit maintenance costs of $3.00 per year for crypts and $2.00 per year for niches. By comparison, the average cost for maintaining inground 5'x10' gravesites is approximately $6.00 per year.

9.2 Unit Costs of Interments and Maintenance

The preceding analyses lead to the unit costs summarized in Table 9-1.

TABLE 9-1

	Interments		Maintenance	
Interment Method	**Productivity Rate (1) Interments/ Man-year**	**Unit Cost Per interment**	**Productivity Rate (2) Acres/or Units/ Man-year**	**Unit Cost Per acre or per unit**
Inground, casketed, 5 or 7 ft. deep excavation	PI	$19,500/PI	PM	$17,000/PM per acre
Inground, casketed, preplaced crypts	350(3) to 450(4)	$ 56.00 $ 44.00	PM	$17,000/PM per acre
Inground, non-casketed	1,200	$ 16.00	PM	$17,000/PM per acre
Above ground, garden crypts	800(3) to 1,000(4)	$ 25.00 $ 20.00	6,000 ± units	$ 3.00 per unit
Above ground, columbaria	1,800	$ 10.00	9,000 ± units	$ 2.00 per unit

(1) PI = Interment Productivity Rate for all inground casketed burials other than preplaced crypts—varies generally from 100 to 300 interments/man-year. See Chapter 7. All other values of Productivity Rates shown are average estimated values of PIX (applying to Alternate X). See Section 10.5(a).

(2) PM = Maintenance Productivity Rate for all inground burials—varies generally from 3 to 14 acres/man-year. See Chapter 8. All other values of Productivity Rates shown are average estimated values of PMX (applying to Alternate X) See Section 10.5(a).

(3) For a number of annual interments = 400 or less.

(4) For a number of annual interments = 2,000 or more.

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10 EVALUATION OF COST EFFECTIVENESS

10.1 Economic Viewpoint

The basic premises established for comparing interment alternatives economically are that:

(1) The Veterans Administration decision-maker is going to commit construction of the necessary additional cemetery site development and other construction inherent in any alternative in sufficient quantity to handle interments for the next 5 years, or less. The selection of a five year period, while arbitrary, is reasonable in terms of the time frame suitable for planning, designing and constructing additions to an existing cemetery; however, any other period judged suitable may be used in making economic comparisons.

(2) The point of economic comparison will be the end of whatever initial construction phase must be completed before interments can take place. The present value of initial construction costs and the cost of land previously developed will be counted at 100% of their current estimated cost. For alternatives with high initial construction costs, such as preplaced or garden crypts, it is likely that budgetary restrictions would dictate phasing. For the purpose of the comparisons made in this section, it will be assumed that 50% of the interment structures required for such alternatives will be constructed in year 0 and 50% in year 3.

(3) All the variable costs inherent in an alternative will be considered: land; site development; construction of interment structures; interment; and perpetual maintenance. The administrative costs of interments; that is, the costs of the cemetery director, his assistants, representatives managing the funeral flow, and clerical backup, have been excluded. These costs will probably not change significantly regardless of the interment alternative being used; but, in any case, no attempt has been made to estimate any differences that might occur.

(4) For the purposes of this analysis the cost of gravesite maintenance for 50 years following the initial interment will be included.

(5) All future expenditures whether for interment structures, interments or maintenance are discounted to present value using a 10% interest rate. The actual discount factors used are as published in OMB Circular No. A-94 (Ref. 10.1) covering discount rates to be used in studies by federal agencies in evaluating time-distributed costs and benefits. A list of discount factors is contained in the Appendix.

(6) In accordance with Circular A-94, all estimates of future expenditures will be based on their cost at the time of economic decision; that is, their *current* estimated cost. No allowance will be made for inflation. This mandated policy of using constant dollars for economic comparisons assumes that the current cost of grave maintenance, for instance, adequately measures the economic impact of grave maintenance many years from now—when the cost of maintenance can be expected to be much higher than at present, but the revenues available to pay for those increased costs can be expected to be correspondingly higher.

10.2 Cost Effectiveness Ratio

The benefits to be derived from adopting an alternative interment method will ordinarily be the decrease in future interment and maintenance costs to be derived at the cost of constructing a more expensive initial installation.

The use of a Benefit-Cost Ratio was considered as a measure of economic effectiveness. The numerator of the ratio would be the present value of the future decrease in interment costs plus the present value of the future decrease in maintenance costs. The denominator would be the present value of the additional cost of constructing the alternative being examined. Its formula comparing control alternative 0 and alternative X would be:

$$BCR = \frac{\text{Present Value of Benefits (Reduced Costs, Interment + Maintenance)}}{\text{Present Value of Additional Cost (Structures + Land + Site Development)}}$$

$$BCR = \frac{(Io \cdot k2 - Ix \cdot k2) + (Mo \cdot k3 - Mx \cdot k3)}{(Cx \cdot k4 + Lx + Sx) - (Co \cdot k1 + Lo + So)}$$

whose terms are defined in the following discussion of Cost Effectiveness Ratio. For this particular analysis it was felt that the value of BCR unduly depended on the interest rate of 10% determining all the k, or discount, values—a rate that is somewhat arbitrary. This is because the benefits (all in the numerator) are all differences between *future* interment and maintenance costs that must be heavily discounted using the stipulated interest rate while the costs in the denominator are either undiscounted or lightly discounted differences between current costs of construction.

Instead we have adopted the Cost Effectiveness Ratio (CER), defined as the ratio of the present value of the life cycle cost of any control alternative to the present value of the life cycle cost of the alternative being examined. When the Cost Effectiveness Ratio = 1.00, the Benefit-Cost Ratio = 1.00; otherwise they are unequal. In the Cost Effectiveness Ratio, as may be seen in the formula that follows, the influence of the interest rate is greatly diminished since it operates equally in the numerator and denominator to discount future interment and maintenance costs.

$$CER = \frac{\text{Present Value } - \text{ Life Cycle Cost of Control Alternative}}{\text{Present Value } - \text{ Life Cycle Cost of Alternative X}}$$

$$CER = \frac{Co \cdot k1 + Lo + So + Io \cdot k2 + Mo \cdot k3}{Cx \cdot k4 + Lx + Sx + Ix \cdot k2 + Mx \cdot k3}$$

where CER = Cost Effectiveness Ratio (dimensionless)

Co = Cost of construction of control alternative interment structures sufficient for 5 years, or less if less than five years of first interment sites will be developed.

k1 = Weighted discount factor applicable to construction of interment structures for the control alternative. The discount factor translates future costs into present values; that is, the "present worth" of those costs.

Lo = Cost of land required for the control alternative.

So = Cost of site development for the control alternative.

Io = Cost of interments for the control alternative (5 years or less).

k2 = Weighted discount factor applicable to interments for all alternatives.

Mo = Cost of maintenance for the control alternative (50 years).

k3 = Weighted discount factor applicable to maintenance for all alternatives.

Cx = Cost of construction of interment structures for the alternative X (any other alternative being compared to the control alternative) sufficient for 5 years or less.

k4 = Weighted discount factor applicable to construction of interment structures for alternative X.

Lx = Cost of land required for alternative X.

Sx = Cost of site development for alternative X.

Ix = Cost of interments for alternative X (5 years or less).

Mx = Cost of maintenance for alternative X (50 years).

The control alternative would normally be the interment method currently being employed in any cemetery. In economic terms you would then compare the cost effectiveness of any other interment method with the control alternative. When the Cost Effectiveness Ratio of the alternative being examined exceeds 1.00, it means that the life cycle cost of the control alternative exceeds the life cycle cost of that alternative and, therefore, that the alternative being examined is more cost effective.

10.3 Control Alternative

The use of inground burials in 5′x10′ gravesites using a durable liner and a marker is the most likely control interment method for any comparisons to be made in connection with casketed burials. This was the most prevalent method in use throughout the National Cemetery System during FY 1978—which the questionnaire data reflects. The use of a 6′x10′ gravesite or some other gravesite size as a control alternative can affect the economic comparisons in a significant way. For instance, the use of a 3.5′x9.5′ gravesite instead of a 5′x10′ gravesite would decrease the CER for preplaced lawn crypts by approximately 15%.

The purchase and installation of a durable liner and the purchase cost of a marker will be considered as the construction cost of the control alternative.

An examination of questionnaire responses indicates that typically liner contracts are made for a year's duration. Accordingly, the costs incurred in relation to liners and markers will typically be incurred in the same year as the costs for interments. For the purposes of this study, then, discount factors k1 and k2 will be equal when inground burials using liners is the control alternative.

10.4 The Impact of Reopeners

Under the control alternative, typically the first interment takes place at the 7 ft. depth in anticipation of reopening the gravesite for a spouse later at the 5 ft. depth. A recent study by the Veterans Administration (Ref. 10.2) for the years 1973-1978 indicates that the national average of dependents interred in the National Cemetery System is 26.2 per cent of total interments. Reopeners for cemeteries in our selected 1978 sample averaged 20 per cent, possibly reflecting the bias of larger cemeteries near large metropolitan areas with high interment rates and wide service areas. Accordingly, we have adopted a reopener rate of 25 percent for this study. This means that reopeners represent 33⅓ per cent of first interments.

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We could not discover any reliable digested data on the average elapsed time between the first opening of a gravesite and the first reopening. The prevailing opinion expressed to us, however, was that it may be 5 years. For the purposes of this study first interments were assumed to occur uniformly through years 1 to 5 and reopeners in those gravesites through years 6 to 10. Results are not sensitive to this assumption. A change from years 6 - 10 to years 4 - 8, for instance, was found to have virtually no effect on the value of CER.

In the case of typical inground burial alternatives, additional liners and markers have to be purchased for reopeners—at the rate of 33⅓ per cent of the initial interments; the situation is identical for garden crypts where an additional casket site and inscription must be committed as each reopening occurs. For preplaced lawn crypts and columbaria niches the space for spouses will typically have been preconstructed. While ⅓ as many additional markers or inscriptions will have to be provided in these cases during years 6 to 10 for reopenings, the discounting of this additional minor cost is so severe as to render it neglible. These impacts of reopeners on cost must be borne in mind in applying the CER formula.

10.5 Application of the Cost Effectiveness Ratio Formula

(a) Required Data

Any two alternatives may be compared by inserting the appropriate values in the formula for CER. In the typical case the following current data and current unit costs would have to be known:

NI	Number of first burials for a 5 year period (or less).
NR	Number of reopenings, normally for spouses, for a 5 year period (or less).
Uo	Unit cost of a liner in place and marker furnished—for Control Alternative.
UL	Unit cost of land, per acre.
US	Unit cost of site develoment, per gross acre (roads, cemetery development, etc.).
PI	Interment Productivity Rate (Interments/man-year) for inground gravesite Control Alternative—usually 5′x10′x7′ or 6′x10′x5′.
PIX	Interment Productivity Rate for Alternative X. See Table 9-1 for average values.
PM	Maintenance Productivity Rate (Acres/man-year or Units/man-year) for inground gravesite Control Alternative.
PMX	Maintenance Productivity Rate for Alternative X. See Table 9-1 for average values.
AI	Annual average salary for interment personnel (interment and headstone operations).

AM	Annual average salary for maintenance personnel.
Ux	Unit cost of Alternative X interment structure and marker (where applicable) per unit installed, including any *special* site development costs (related stone walks, for instance) required in excess of basic site development for that alternative to be used effectively.
UM	Unit cost of maintenance per above ground crypt or niche per year.
Do	Density of Control Alternative in gravesites per gross acres. See Table 10-1 for average values.
Dx	Density of Alternative X in burial units or gravesites per gross acre of cemetery. Gravesites per gross acre should be used for all inground burial alternatives; for above ground alternatives burial units (such as crypts or niches) per gross acre should be used. See Table 10-1 for average values.
EI	Escalation factor for basic interment costs, equals AI divided by the national average 1978 value of $14,400.
EM	Escalation factor for basic maintenance costs, equals AM divided by the national average 1978 value of $13,000.

(b) Formulas for Calculations

Item	**Control Alternative**	**Alternative X**
Interment Structures	$Co = Uo \cdot (NI + NR)$	$Cx = Ux \cdot NI^*$
Land	$Lo = UL \cdot NI/Do$	$Lx = UL \cdot NI^*/Dx$
Site Development	$So = US \cdot NI/Do$	$Sx = US \cdot NI^*/Dx$
Interments	$Io = \$19{,}500/PI \cdot (NI + NR) \cdot EI$	$Ix = \$19{,}500/PIX \cdot (NI + NR) \cdot EI$
Perpetual Maintenance	$Mo = \$17{,}000/PM \cdot NI/Do \cdot EM \cdot 50$ yrs	$Mx = \$17{,}000/PMX \cdot NI^*/Dx \cdot EM \cdot 50$ yrs or $Mx = UM \cdot NI^* \cdot EM \cdot 50$ yrs (for above ground interments)

* Use NI in any alternative where the initial gravesite or burial unit construction provides additional burial space for reopenings, such as with preplaced double depth crypts and columbaria niches, but use (NI + NR) in any alternative where reopenings will require their own additional burial units, such as with garden crypts.

(c) Gross Densities

Analysis of the sample cemeteries revealed that the average density per gross acre was 530 gravesites/acre. The prevalent grave size within the system was 5′x10′, indicating that the maximum achievable density per net acre was 870 gravesites/acre. This in turn implies the following relationship pertaining to the sample national cemeteries as they now exist: 1 net acre = 870/530 = 1.64 gross acres; that is, it requires 1.64 gross acres of land to yield 1 net acre of gravesites. In view of the fact that the design philosophy for new cemeteries tends to incorporate a larger percentage of natural buffer areas, this ratio is likely to increase. The Veterans Administration has estimated that the ratio could rise to 1.1 net acres per 2 gross acres, or 1 net acre = 1.82 gross acres.

Analysis of the master plan for the 902 acres Calverton N.C. in New York, where gravesite areas are being carved out of relatively flat wooded land, indicates a relationship of 1 net acre = 1.62 gross acres; this ratio could of course increase during development of the cemetery. On balance, therefore, for any interment method, once the density of gravesites per net acre has been defined by the selection of the gravesite size or by the number of above-ground units divided by their immediate construction area, it appears reasonable to determine the densities per gross acre by the relationship:

$$\text{Density per gross acre} = \frac{\text{Density per net acre}}{1.70}$$

For above-ground interment methods, it is necessary to adopt a specific design prototype in order to determine the density of burial units per net acre. The only above-ground methods that seem to have any relevance for national cemeteries in the immediate future are columbaria and garden crypts.

Two possible prototype garden crypts were illustrated in Figure 5.9. The two module plan results in a density of 2,700 crypts per net acre and the three module plan in a density of 2,900 crypts per net acre. In each instance a pull out roadway "parking area" and the size of clearing required for peripheral grading and construction were counted as the net site areas. Accordingly, we have adopted 2,800 crypts per net acre average density for the prototypes selected as appropriate for this study.

The prototype columbaria wall design illustrated in Figure 5.11 results in a relatively low density of 3,600 niches per net acre. As discussed in Chapter 5, this density can be increased through design, but a low density prototype has been selected for economic comparison in as much as it is probably more appropriate to the newer informal cemeteries emerging in the system.

Table 10-1 summarizes average gross density values for different types of interment methods. In all instances, the density per gross acre has been derived from the density per net acre by dividing by 1.70. The principle involved is that all interment methods examined should share equally in the amount of common use space (roads, buildings, buffers, etc.) required for their proper functioning and support.

(d) Discount Factors

Some time scale must be applied to the costs incurred in any interment method in order to determine the present value or present worth costs incurred throughout the life cycle of the gravesite. The economic viewpoint set forth in Section 10.1 will be used throughout. It results in the weighted discount factors listed in Table 10-2. In all cases of costs incurred over a series of years they are assumed to be uniform annual costs, permitting averaging of the applicable discount factors.

The weighted discount factors shown in Table 10-2 assume (1) 25% reopeners occurring in years 6 though 10 and (2) 50% of crypts and niches, except for add-on niches, constructed in year 0, 50% in year 3. If circumstances for any particular cemetery are known to be markedly different, the data in the table can easily be adjusted by inserting the appropriate discount factors from OMB Circular A-94, a listing of which may be found in the Appendix.

TABLE 10-1

Interment Method	Interment Structure	Gravesite or Unit Size	Density of Gravesites (G) or Burial Units (U)	
			Per Net Acre	Per Gross Acre
Inground Burial				
Casketed	Liner*	3.5'x9.5'x7'	1,310G	771G
Casketed	Liner*	5'x10'x7'	871 G	512G
Casketed	Liner*	6'x10'x5'	726G	427G
Casketed	Preplaced Double Depth Lawn Crypt**	3'x8'-1"x7'	1,797G	1,057G
Urn	Marker	5'x5'x2'-6"	1,742G	1,025G
Above Ground Interment				
Casketed	Garden Crypt	2'-8"x7'-6"x2'-4"	2,800U	1,650U
Urn	Free-Standing Columbaria Wall Niche	10"x10"x1'	3,600U	2,100U

* Liner and marker or marker only, where no liner is used

** Plus marker

TABLE 10-2

Cost Item	Years in which Cost is Incurred	Average Discount Factor	Fraction of Total	Weighted Discount Factor
Interment, First Burials	1 - 5	0.758	0.75	0.569
Interment, Reopenings	6 - 10	0.471	0.25	0.118
Interment, Total			1.00	k2 = 0.687
Liners	Same as Interments			k4 = k1 = 0.687
Crypts and Niches	0	1.000	0.50	0.500
	3	0.751	0.50	0.375
			1.00	k4 = 0.875
Add-on Niches	0	1.000	1.00	k4 = 1.000
Perpetual Maintenance	1 - 50	0.198	1.00	0.198

(e) Productivity and Unit Costs

Productivity rates for the various alternative interment methods considered here are discussed in Chapter 9 and typical unit costs for interments and maintenance are derived and presented in Table 9-1.

(f) Numerical Example

A numerical example of the application of the Cost Effectiveness Ratio equation will be given for the situation in which a Veterans Administration decision-maker desires to compare the alternative of using preplaced double depth lawn crypts to an existing system of 5'x10' gravesites with liners being used in a particular national cemetery—assuming 750 first interments per year for 5 years.

First of all, he must assemble the required data as set forth in Section 10.5(a), which includes the definitions of all the symbols used:

NI = 3,750 first interments

NR = .333 (3,750) = 1,250 reopeners

PI = 190 interments/man-year

PM = 6.5 acres/man-year

PIX = (Table 9-1) = 390 interments/man-year

AI = $16,600/yr

AM = $14,800/yr

EI = $16,600/$14,400 = 1.15

EM = $14,800/$13,000 = 1.14

Uo = $ 90 per liner
$ 60 per marker
$ 150 total

UL = $30,000/acre

US = $50,000/acre

Ux = $280 per preplaced double depth crypt
$ 60 per marker
$340 total

Do = 512 gravesites/gross acre (Table 10-1)

Dx = 1,057 gravesites/gross acre (Table 10-1)

In the case of an existing cemetery operation, the values of N, P and A should already be a matter of record. In the case of a cemetery not yet in operation, these values would have to be estimated using the data presented in this report for cemeteries with similar environmental conditions and in similar wage areas. With respect to unit costs, it is assumed that Uo would normally be a matter of record. Current estimates of the unit costs of site development (US) and land (UL) can normally be obtained from the Office of Construction if not already known with respect to the cemetery in question. Ux should be a current estimate of the cost of construction of the alternative using a specific design concept and site plan so as to ensure that all costs will be adequately reflected. Dx should be derived from the site plan proposed for all above-ground alternatives since the values presented in Table 10-1 may prove too approximate. The collected data must then be inserted in the formulas for calculations outlined in Section 10.5(b) and multiplied by the appropriate discount factors from Section 10.5(d) to quantify each member of the Cost Effectiveness Ratio Formulas set forth in Section 10.2.

Member of Equation		**Present Value**
Cok1	= \$150 • (3,750 + 1,250) (.687)	\$ 515,250
Lo	= \$30,000/Ac (3,750/512)	219,727
So	= \$50,000/Ac (3,750/512)	366,211
Iok2	= \$19,500/190 • (3,750 + 1,250) (1.15) (.687)	404,420
Mok3	= \$17,000/6.5 (3,750/512) (1.14) (50) (.198)	216,191
Present Value, Life Cycle Cost, 5′x10′ gravesites with liners		\$ 1,721,799
Cxk4	= \$340 (3,750) (.875)	1,115,625
Lx	= \$30,000/Ac (3,750/1057)	106,433
Sx	= \$50,000/Ac (3750/1057)	177,389
Ixk2	= \$19,500/390 (3,750 + 1,250) (1.15) (.687)	197,513
Mxk3	= \$17,000/6.5 (3,750/1,057) (1.14) (50) (.198)	104,721
Present Value, Life Cycle Cost, Preplaced Double Depth Lawn Crypts		\$ 1,701,681

$$\text{CER} = \frac{\text{Present Value, Life Cycle Cost, 5′x10′ gravesite with liners}}{\text{Present Value, Life Cycle Cost, Preplaced Double Depth Lawn Crypts}}$$

$$\text{CER} = \frac{\text{1,721,799 (5′x10′ with liners)}}{\text{1,701,681 (preplaced lawn crypts)}} = 1.01^{*}$$

*The corresponding Benefit-Cost Ratio (BCR), as discussed in Section 10.2, for this example would be 1.07.

In this example it proves to be cost effective to construct preplaced lawn crypts because the present value of the life cycle costs of 5′x10′ gravesites using liners is 1% higher than the present value of the life cycle costs of preplaced crypts.

This example develops 3,750 gravesites for 5,000 interments. The life cycle costs for

5'x10' gravesites with liners are $459 per gravesite and $344 per interment, while for the preplaced lawn crypts the life cycle costs are $453 per gravesite and $340 per interment. Lawn crypts would therefore achieve a savings of $4 per interment in this particular example.

The capital construction costs required for these two alternatives are markedly different. The 5'x10' gravesites require an initial expenditure for site development of only $366,211 while the lawn crypts require an initial expenditure of $177,389 for site development and $637,500 for the first phase of preplaced crypts, with a second expenditure of $637,500 for preplaced crypts several years later.

10.6 Procedures for Comparing the Cost Effectiveness of Alternative Methods

(a) Types of Comparisons

There are two different types of comparison:

Type A in which the remainder of a cemetery or a large portion of it is going to be converted to an alternative method for all or virtually all interments that will take place, for at least several years, should the alternative method prove cost effective. The interment and maintenance manpower will be tailored to the specific needs created by the alternative method. Type A comparisons would also apply to the master planning of the various phases of new cemeteries that do not yet exist.

Type B in which a portion of an existing cemetery is going to be converted to an alternative method should it prove cost effective while the remainder of the cemetery simultaneously continues to use the present method of interment. The present interment and maintenance manpower will be needed in conjunction with operations throughout the remainder of the cemetery and will not be reduced even if that portion of the cemetery utilizing the alternative method could function with less manpower. Eventually, the long-term benefits of reduced maintenance will very likely be achieved by adding less maintenance personnel as cemetery development expands but, in the short term, the benefits of increased interment productivity will only be marginally enjoyed, if at all. If the alternative method requires more manpower per interment or per acre, on the other hand, an incremental addition of manpower will be made to meet the needs of that method for as long as it will be employed.

The principal differences, in terms of economic comparison, between Type A and Type B comparisons are:

(1) Under Type B comparisons, while the benefits related to reduced land area, site development and maintenance will be realized, alternative methods will not derive an economic benefit for increased interment productivity.

(2) Type A comparisons will ordinarily involve a large area and more than 5 years of first interments. The economic viewpoint set forth in Section 10.1 measuring the impact of 5 years of first interments, reflected in the average weighted discount factors presented in Table 10-2, will adequately measure cost effectiveness. Type B comparisons will ordinarily involve a limited area that often will accommodate less than 5 years of first interments; in those instances, the comparison of alternative methods will be based on discount factors different from those in Table 10-2.

(b) Step-by-Step Procedures

(1) Develop a plan, at least in sketch form, for each alternative to be examined. Each plan should involve the same number of first interments, even though the disturbed site areas may be different. This is essential in order to keep the economic time frame and discounting of future benefits equivalent in all alternatives. In Type A comparisons use the number of interments for 5 years if the area being examined will hold more than 5 years of first interments—using the alternative with the lowest density of gravesites per acre.

In Type B comparisons use the number of first interments that the alternative with lowest density of gravesites per acre requires to fill the area of cemetery being analyzed. Do not use the existing method that will continue to be used simultaneously in other parts of the cemetery. Round the number of first interments downward to the nearest product of whole years (5 maximum) times the annual rate of first interments. For example, if preplaced lawn crypts will produce 4,850 gravesites within the area being analyzed and the annual first interment rate is 1,100, compare all alternative interment methods for 4,400 first interments occurring over 4 years. This permits the economic analysis to be based on whole year discount factors as listed in Appendix D.

(2) Determine from the sketch plans the density of gravesites or burial units (crypts, niches, etc.) per net acre by measuring the net acres that will be disturbed in constructing the specified number of gravesites or burial units required to accommodate the selected number of first interments. Use only the area disturbed to construct the gravesites or burial units and the site work specifically related to that method, such as related walks and parking area. Do not include undisturbed areas or cemetery roads that have to be extended to gain access to the area. Convert net acres to gross acres for *all* alternatives by multiplying by 1.70, unless an alternative ratio of gross to net acres has been determined by analysis of the plan for the whole cemetery or a major sector of it. This allows each alternative to share evenhandedly in the common areas of land occupied by roads, ponds, buildings and undisturbed buffer zones.

In the absence of sufficiently definitive sketch plans, the gross densities may be estimated on the basis of Table 10-1.

(3) Prepare current estimates of unit costs of construction for all alternative interment structures, including grave markers where the markers are separate from the interment structures. Include all special sitework, such as parking areas, walks or retaining walls, that must be added to the basic cost of developing the cemetery area. In the case of alternative methods using liners, use the estimated cost of a liner furnished and placed plus the estimated cost of a marker furnished. Do not include the cost of clearing and grading the site or topsoiling and seeding the finished area; these costs, along with roads, storm drainage and utilities, are part of basic cemetery site development costs.

(4) Complete FORM B, PRESENT VALUE OF LIFE CYCLE COSTS, for each alternative interment method. An example is given in Appendix G comparing four years of first interments using preplaced double depth lawn crypts to continuing the use of 6′x10′x5′ gravesites using liners. Current values of land and site development unit costs must be determined along with current annual interment and maintenance salaries for the cemetery in question and current or estimated interment and maintenance productivity rates. The unit cost of land to be used should be decided on the basis outlined in Chapter 6. The unit cost of site development should be based on an analysis of the topography, subsoil data, the plan for development, and current local unit costs—or previous bids on similar development. If the extent of earth moving required is different for the various alternatives being examined, then different unit costs of site development should be used. Annual salaries and productivity rates, in the case of an existing cemetery, should be based on the previous year's records. In the case of a cemetery being planned, salaries must be estimated by the central office of the Veterans Administration. Productivity rates can be estimated by comparison to an existing national cemetery nearby having reasonably similar environmental and operational characteristics; the guidelines set forth in Chapters 7 and 8 should be referred to for general guidance. The values in Table 9-1 may be used for estimating productivity rates for alternatives where no comparable examples can be found.

For Type B comparisons, the current interment productivity rate should always be used for all alternatives being compared unless their estimated productivity rates are lower than the current rate.

All unit costs should be current, that is, estimated costs applicable at the time the economic analysis is being made (Year 0) including the unit cost of any site development that may have been completed in the years before the analysis is being made. When considering a future phase of development (or portion of a phase) in a master plan, use current unit costs and analyze the area as if it will be constructed in Year 0 of the analysis.

(5) For comparisons where less than 5 years of first interments are to be compared, complete FORM C, ALTERNATIVE DISCOUNT FACTORS (See Appendix G).

(6) Complete FORM A, SUMMARY OF COST EFFECTIVENESS RATIOS (See Appendix G), including conclusions on the most cost effective method of interment.

10.7 Typical Cost Effectiveness Comparisons

For the purpose of establishing an overview of the relative cost effectiveness of alternatives, typical costs related to prototype interment methods judged appropriate in Chapter 5 for use under certain conditions in national cemeteries will be compared with typical costs related to in-ground and above-ground control alternatives to determine their cost effectiveness. Such comparisons will necessarily be approximate, but reasonably accurate, and only shed light on typical, or average, situations.

The tables and charts found in this section are equally approximate but they permit a number of variables to be considered rapidly and inappropriate methods to be quickly discarded. In trying to arrive at a decision, however, the detailed CER equation should always be used following the step-by-step procedures outlined in Section 10.6

(a) Sensitivity to Cost Variations

The Cost Effectiveness Ratio formula contains 11 variables and 6 constants that must be quantified. For simplified comparisons, only 4 variables can be handled; the other 7 must be assigned average constant values. The Cost Effectiveness Ratio is most strongly influenced by the cost of liners (Co), the cost of constructing alternative interment structures (Cx) and the cost of inground interments (Io or Ix). For certain comparisons, the unit cost of inground gravesite maintenance becomes important.

All other members of the CER equation will be treated as constants for the purpose of making an approximate economic comparison of alternatives. The same value for the unit cost of land per acre and site development per acre will be used in the numerator and denominator of the equation; only the number of acres will vary, depending on the prototype for each alternative.

The cost of maintenance per acre is not, in fact, a constant as has already been discussed. Because of the heavy discounting of the value of maintenance over 50 years, however, this member of the equation has only minor influence on the value of CER, except for comparisons of inground alternatives with above-ground alternatives. For the purpose of this analysis we have adopted for the control alternative and other inground interment alternatives the average cost encountered in our sample of large active cemeteries, that is, $3,000 per acre per year, escalated to a current value of $3,700 per acre—which also allows 10% ± for irreducible sinkage repair costs. The sensitivity of CER to this assumption was investigated and it was found that increasing maintenance costs 50% would change CER values up to 4% when two inground alternatives are compared—probably not significant for approximate comparisons. However, it was found that when above-ground alternatives are compared with inground alternatives, the unit cost of maintenance for the inground alternative has a significant impact on the value of CER; accordingly, adjustment factors have been provided in the examples that follow. Potential variations in the constant cost of maintenance we assigned to each of the above-ground interment methods would have only minor impact on the value of CER.

The variables (Co, Cx, Io, Ix) will vary in value throughout the National Cemetery System. Variations in control alternative interment costs (Io) can be handled by the application of an escalation factor that takes into account both the variations in the regional interment cost indices presented in Table 7-3 and escalation since the base year, FY 1978. Variations in the alternative interment costs (Ix) for preconstructed crypts and niches will normally not have anywhere near the impact of variations in the control alternative interment costs (Io) since the value of Ix will usually be several times less than Io; otherwise there would not be much reason to consider the alternative. For this reason the value of Ix has been established as a constant for each prototype, except for normal inground burials, even though there is bound to be some variation. The sensitivity of CER to this assumption was investigated and it was found that increasing Ix by applying an Interment Cost Index of 1.25 would decrease CER by approximately 2 per cent and decreasing Ix by applying an Interment Cost Index of 0.75 would increase CER by approximately 2 per cent.

The two principal variables related to construction costs (Co and Cx) can be expected to vary widely—depending on the local construction labor markets, distance from the source of materials, etc. Normally these variations can be handled by a regional cost index. Investigations during the study determined that the R.S. Means index data (Ref. 10.3) was the most applicable but that their site labor index did not compare closely with the interment cost index derived from an analysis of sample cemeteries. Also, liner costs throughout the National Cemetery System were seen to have varied widely and without following any rational regional cost index trend. Similar observations were made on quotations received relative to unit costs for interment structures for several of the alternative interment methods. The final conclusion reached was that variations in the construction costs of interment structures should not be handled by a regional construction cost index. Instead, tables and graphs should be prepared displaying a range of possible construction costs. The assumption is made that the Veterans Administration decision-maker will be able to estimate the costs of liners and alternative interment structures available in the vicinity of any given cemetery. Moreover, this method allows the decision-maker to vary the prototype details in considering any alternative so long as he takes the variation in unit cost into account.

The Cost Effectiveness Ratio is also mildly sensitive to the assigned values of land and site development per acre. Considering all the variables that may differ from the constant values assigned in the tables and graphs that follow, we estimate that the maximum probable error in using these ready reference materials is approximately 5%. As an illustration of this, if the previous detailed example comparing lawn crypts costing $340 per crypt and marker with 5′x10′ gravesites utilizing $90 liners and having a productiviy rate of 190 interments/man-year and an interment escalation factor of 1.15 had been compared using the simplified data that follows, the CER would have been 0.98 instead of 1.01—a difference of 3%. Had the previous detailed example used the same unit costs for land and site development, the CER would have been 0.98 instead of 0.94—a difference of 4%.

(b) Prototypes Compared

The following nine prototype methods will be compared with respect to cost effectiveness, and will be referred to as Alternatives 0 through 8:

No.	**Description**
	Control Alternative for Casketed Remains:
0	5′x10′x7′ gravesite for 2 or more interments using durable liners (concrete box with lid, concrete bell, fiberglass bell, metal box, cast-in-place "dry pack" concrete, etc.)
	Inground Burial Alternatives:
1	5′x10′x7′ gravesite — no liner
2	6′x10′x5′ gravesite — durable liner
3	3.5′x9.5′x7′ gravesite — durable liner
4	Preplaced Lawn Crypts: 3′-0″ × 8′-1″ × 7′ gravesite with preplaced precast concrete double depth crypts capable of receiving two interments.

5 **Garden Crypts:**

Crypts 2'-9" × 2'-4" × 7'-6" constructed in structures with rows 2 and 3 crypts wide and 7 crypts high each side of a service aisle. Structure to be stone clad and provide for remote memorialization and committal service shelter at one end.

6 **Control Alternative for Inground Cremains:**

5'x5' × 2.5' gravesite capable of receiving 2 interments using "obstructed" gravesite areas.

7 **Columbaria:**

Niches 10"x10"x1'-0" constructed in free standing garden walls, 2 niches deep and 6 niches high.

8 **Add-On Columbaria:**

Niches 10"x10"x1'-0" added on to walls and buildings required for other purposes.

(c) Unit Cost and Economic Data

The unit cost data and other constants used in the economic comparisons that follow are summarized in Table 10-3. We have in general adopted the average values encountered in our sample of larger active cemeteries. Estimates of the construction cost of interment structures encompass the range of current unit costs discussed in Chapter 6.

All members of the CER equation, as treated in the tables and graphs that follow, are proportional to the annual interment rate so that, for the same value of interment productivity (PI), the value of CER does not depend on the annual interment rate. The same pertains to life cycle costs.

(d) Life Cycle Costs per Veteran Family Unit

The unit of comparison will be the veteran family unit, that is, the veteran and ⅓ as many dependents. Use of the constants listed in Table 10-3 leads to the development of the simplified equations listed in Table 10-4 for the life cycle costs per veteran family unit for each of the alternative methods to be compared. The derivation of the equations can be found in the Appendix. The life cycle unit costs derived provide for interment, and interment structures where applicable, for the veteran and his dependents at the rate of one dependent for each 3 veterans.

The equations in Table 10-4 have been evaluated in Table 10-5 for the values of Uo, Ux, PI/EI, PIX/EI, PM and Fs set forth in Table 10-3. The Cost Effectiveness Ratio of any alternative interment method compared with any other method may be obtained by dividing the present values of their life cycle costs per veteran family unit. The method with lesser cost is the more cost effective method. Values of life cycle cost other than those tabulated may be obtained by linear interpolation within the tables.

These data have also been plotted in Figures 10.1 through 10.7 in such a manner as to permit the rapid determination of the Cost Effectiveness Ratio of the various alternative interment methods compared to control alternatives. In Figures 10.1 through 10.5, the Present Value of the Life Cycle Cost of the 5'x10' gravesite control alternative may be read on the basis of the value of PI/EI. In most cases, three values must be known:

TABLE 10-3

CONSTANTS USED TO CALCULATE AVERAGE CER VALUES

Do, Dx —	Densities:	See Table 10-1
k1 – k4 —	Discount Factors:	See Table 10-2
Uo —	Unit Cost of Liners:	$50, $100, $150
Uo —	Unit Cost of Markers:	$60
UL —	Unit Cost of Land:	$15,000/Gross Acre
US —	Unit Cost of Site Development:	$35,000/Gross Acre
Ux* —	Unit Cost of Preplaced Double Depth Lawn Crypts:	$250, $300, $350, $400
Ux* —	Unit Cost of Garden Crypts:	$400, $500, $600, $700
Ux* —	Unit Cost of Columbaria Wall Niches:	$100, $150, $200, $250
Ux* —	Unit Cost of Add-On Columbaria Niches:	$50, $75, $100

* (Including marker or inscription)

Unit Costs of Interments and Maintenance

Interment Method	Interments	Maintenance/Year
Liner	$19,500/PI	$3,700 per acre
Inground - No Liner	$19,500/PI	$3,700 per acre
Preplaced Double Depth Lawn Crypts	$ 50.00	$3,700 per acre
Garden Crypts	$ 23.00	$ 3.00 per unit
Columbaria Wall Niches	$ 10.00	$ 2.00 per unit
Add-On Columbaria	$ 10.00	$ 2.00 per unit
Inground Cremains	$ 16.00	$3,700 per acre × 5.67/PM

Fs — Sinkage Factor 1.30, 1.50, 1.70

PI/EI — Interment Productivity/ Escalation Index 100, 150, 200, 250, 300, 350 Interments/Man-year

PM — Maintenance Productivity Rate 3 through 14 Acres/Man-year

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TABLE 10-4

Alternative No.	Present Values of Life Cycle Cost per Veteran Family Unit (Dollars)
0	$.916\ Uo + 17{,}862 \cdot EI/PI + 169.20$
1	$71.54\ Fs + 17{,}862 \cdot EI/PI + 152.61$
2	$.916\ Uo + 17{,}862 \cdot EI/PIX + 202.88$
3	$.916\ Uo + 17{,}862 \cdot EI/PIX + 112.36$
4	$.875\ Ux + 127.76$
5	$1.166\ Ux + 101.05$
6	$118.38 + 202.62/PM$
7	$.875\ Ux + 52.77$
8	$1.000\ Ux + 28.96$

TABLE 10-5

TYPICAL PRESENT VALUES OF LIFE CYCLE COSTS

PER VETERAN FAMILY UNIT

LCC(0) THROUGH LCC(8)

Alternate 0: 5′x10′ gravesite with durable liner

Unit Cost Liner	PI/EI 100	150	200	250	300	350
$ 50	$448.60	389.10	359.30	341.40	329.40	321.10
$100	494.40	434.90	405.10	387.20	375.20	366.90
$150	540.20	480.70	450.90	433.00	421.00	412.70

Alternate 0: Adjustments to Present Value When Compared with Alternate 5

Maintenance Productivity Rate (Acres/Man-year)

3	4	5	6	7	8	9	10	11	12	13	14
+ 64.30	+ 30.40	+ 10.00	− 3.60	− 13.30	− 20.60	− 26.20	− 30.80	− 34.50	− 37.60	− 40.20	− 42.40

Alternate 1: 5′x10′ gravesite without liner

Sinkage Factor	PI/EI 100	150	200	250	300	350
1.30	$424.20	364.80	334.90	317.10	305.10	296.70
1.50	438.50	379.10	349.20	331.40	319.40	311.00
1.70	452.90	393.40	363.50	345.70	333.70	325.30

Alternate 1: Correction Factors for CER of $\frac{\text{Alternate 0}}{\text{Alternate 1}}$

Sinkage Factor	Maintenance Productivity Rate (Acres/Man-year) 3	4	5	6	7	8	9	10	11	12	13	14
1.30	.91	.95	.98	1.01	1.02	1.04	1.05	1.06	1.07	1.08	1.08	1.09
1.50	.89	.94	.98	1.01	1.03	1.05	1.06	1.08	1.09	1.10	1.11	1.11
1.70	.87	.93	.98	1.01	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.14

Alternate 2: 6′x10′ gravesite with durable liner

Unit Cost Liner	PIX/EI 100	150	200	250	300	350
$ 50	$482.30	422.80	393.00	375.10	363.10	354.73
$100	528.10	468.60	438.80	420.90	408.90	400.53
$150	573.90	514.40	485.60	466.70	454.70	446.30

Alternate 3: 3.5′x9.5′ gravesite with durable liner

Unit Cost Liner	PIX/EI 100	150	200	250	300	350
$ 50	$391.70	332.30	302.40	284.60	272.60	264.20
$100	437.50	378.10	348.20	330.40	318.40	310.00
$150	483.30	423.90	394.00	376.20	364.20	355.80

Alternate 4: Preplaced double depth lawn crypts

Unit Cost Crypt and Marker Installed	Present Value of Life Cycle Cost
$250	$346.50
$300	390.20
$350	434.00
$400	477.70

Alternate 5: Garden crypts

Unit Cost Crypt Installed	Present Value of Life Cycle Cost
$400	$567.50
$500	684.10
$600	800.70
$700	917.30

Alternate 6: 5′x5′ gravesites for cremains

Maintenance Productivity Rate (Acres/Man-year)											
3	4	5	6	7	8	9	10	11	12	13	14
185.90	169.00	158.90	152.20	147.30	143.70	140.90	138.60	136.80	135.30	134.00	132.90

Alternate 7: Columbaria walls

Unit Cost Niche Installed	Present Value of Life Cycle Cost
$100	$140.30
$150	184.00
$200	227.80
$250	271.50

Alternate 8: Add-on columbaria niches

Unit Cost Niche Installed	Present Value of Life Cycle Cost
$50	$ 79.00
$75	104.00
$100	129.00

Uo — the current unit cost of liners (Alt. 0, 2, 3)

Ux — the current unit cost of the alternative interment structure to be compared (Alt. 4, 5, 7, 8)

PI/EI or PIX/EI — the interment productivity/escalation index where PI is the number of annual interments per man-year using inground interments in 5'x10' gravesites; PIX is the same ratio for any Alternative X; and EI is an interment escalation factor equal to the current average interment annual salary divided by $14,400, the national average interment salary in FY 1978 on which the tables and graphs are based. The escalation factor, EI, takes into account both the system-wide variations from the national average interment salary and the escalation in those costs since FY 1978, the data base for this study.

To evaluate Alternative 1 (5'x10' gravesites using no liners) the value of the current sinkage factor (Fs) must be known or estimated. The sinkage factor is the ratio of total maintenance man hours to the man hours required for all maintenance work other than the man hours required for sinkage repair work. It is a direct measure of how much the maintenance effort must be increased because of sinkage problems.

The present value of life cycle cost under Alternative 1 is sensitive to variations in the annual cost of routine maintenance because that cost in turn determines the annual cost of sinkage repairs. The two costs are related through the cemetery's sinkage factor. To account for this sensitiviy a correction factor has been included in Table 10-5 that must be multiplied by the Cost Effectiveness Ratio obtained when comparing Alternate 1 (No Liners) to Alternate 0 (Liners) in 5'x10' gravesites. The correction factor would be slightly different for other gravesite sizes. In order to determine the appropriate value of the correction factor to apply, the maintenance productivity rate, expressed as adjusted maintained acres per man-year, must be known. The average maintenance cost of $3,000/acre/yr. determined in Chapter 8 corresponds to a productivity rate of 5.67 acres/man-year; that rate therefore corresponds to a correction factor of 1.00. Correction factors for other productivity rates range from 0.87 at a minimum productivity rate of 3 acres/man-year to 1.14 at a maximum productivity rate of 14 acres/man-year. Thus, the Cost Effectiveness Ratio of Alternate 1 can vary as much as 27% depending on the cemetery's maintenance productivity rate, or rather, depending on the annual sinkage repair costs that are defined by that rate and the sinkage factor.

When comparing above-ground Alternate 5 (garden crypts) with Alternate 0 (5'x10' gravesites with liners), the value of CER becomes sensitive to the unit cost of maintenance for Alternate 0 which in turn depends on the maintenance productivity rate. An adjustment of the present value of Alternate 0 has been included in Table 10-5 which should be added to or subtracted from the uncorrected present value depending on the cemetery's maintenance productivity rate.

When comparing above-ground Alternates 7 and 8 (columbaria niches) with Alternate 6 (5'x5' gravesites), the value of CER is equally sensitive to the unit cost of maintenance for Alternate 6. Accordingly, the present value of Alternate 6 in Table 10-5 depends on the cemetery's maintenance productivity rate.

(e) 5'x10' Gravesite — No Liners (1) Compared with Durable Liners (0)

Alternatives 0 and 1 have the same land, site development and basic maintenance costs and are assumed to have the same interment productivity and therefore same interment costs. They differ in that Alternative 0 requires a liner and marker while Alternative 1 requires only a marker and Alternative 1 has much higher sinkage repair costs because of the lack of liners.

As an example:

Alternative 0	**Alternative 1**
PI = 170	PIX = 170
EI = 1.21	EI = 1.21
PI/EI = 140	PIX/EI = 140
Unit Cost Liners $80	Fs = 1.30
PM = 7	PM = 7

From Table 10-5, by interpolation, the Present Value of the Life Cycle Cost of Alternative 0, LCC(0) = \$428.50, LCC(1) = \$376.70 and the correction factor is 1.02. The Cost Effectiveness Ratio of Alternative 1 compared with Alternative 0 is:

CER = LCC(0)/LCC(1) = \$428.50/\$376.70 = 1.14 (Uncorrected)

CER = 1.14 × 1.02 = 1.16 (Corrected)

The same result can be obtained graphically as shown in Figure 10.1.

Another example will help illustrate the impact of the sinkage factor on the cost effectiveness of not using liners:

Alternative 0	**Alternative 1**
PI/EI = 100	PIX/EI = 100
Unit Cost Liners = $50	Fs = 1.70
PM = 4	PM = 4

From Table 10-5, LCC(0) = \$448.60, LCC (1) = \$452.90 and the correction factor is 0.93.

CER = \$448.60/\$452.90 = 0.99 (Uncorrected)

CER = 0.99 × 0.93 = 0.92 (Corrected)

The first example uses a liner cost, interment productivity rate, sinkage factor and maintenance productivity rate close to the average values found for the 22 sample cemeteries examined during this study. It indicates that, with all factors taken into account, burying without liners is 16% more cost effective than if liners are used—both assuming the same size gravesite. In real terms the difference between alternatives represents a present value of \$51.80 life cycle savings per veteran family unit. Nevertheless there is still an offsetting "cost" to consider: the cost of poor appearance. Even when excessive sinkages can be economically repaired by an increase in maintenance effort, the overall appearance of a cemetery where this is occurring can never match one in which sinkages rarely occur—and there is serious question, if the problem is pervasive and noticeable, as to whether that cemetery is fulfilling its goal of providing the veteran with a burial ground maintained as well as he could reasonably expect in the private sector.

In the second example we have selected a liner cost close to the minimum reported; a very high sinkage factor, close to the maximum reported; and a very low maintenance productivity factor, close to the minimum reported. Under these conditions it is not cost effective to bury without liners (CER less than 1.00).

(f) 6′x10′ Gravesite (2) Compared with 5′x10′ Gravesite (0)

Our example will assume that both alternatives employ some sort of durable liner. The costs of land, site development and perpetual maintenance will be greater for the 6′x10′ gravesite because it occupies 20% greater land area. In comparing these two alternatives it is important to recognize that there will usually exist an important environmental factor influencing the decision to adopt the wider and shallower 6′x10′x5′ gravesite system. Normally it will be a shallow groundwater table; a high rock surface (or hard pan); or sand strata that collapse regularly when excavated to 7 ft. deep but have sufficient silty upper cap material to permit excavation to the 5 ft. depth without significant collapse. Whatever the factor, the choice of, or switch to, the 6 ft. wide gravesite is made in order to improve interment productivity.

A typical example would be:

Alternative 0	**Alternative 2**
PI = 121	PIX = 170
EI = 1.21	EI = 1.21
PI/EI = 100	PIX/EI = 140
Unit Cost Liners = $80	Unit Cost Liners = $80

From Table 10-5, by interpolation, LCC(0) = $476.10 and LCC(2) = $462.20

The Cost Effectiveness Ratio of Alternative 2 compared with Alternative 0 is:

CER = LCC(0)/LCC(2) = $476.10/$462.20 = 1.03

The same results can be obtained graphically as shown in Figure 10.2. In that instance, it is necessary first to calculate a factor that measures the difference in productivity costs between the two alternatives:

(EI/PI − EI/PIX) = (1/100 − 1/140) = .0029

The example used illustrates the cost effectiveness of selecting the wider, shallower Alternative 2 in order to achieve a productivity increase from a low value of 121 interments per man-year (approximately 14.7 manhours per interment) to an average value of 170 interments per man-year (approximately 10.5 man hours per interment). Our example indicates that the 6′x10′x5′ gravesites will be 3% more cost effective than the 5′x10′x7′ gravesite if such an increase in productivity can be achieved.

In making the above comparison it has been assumed that the two-thirds of 3′x10′ half gravesites available for, but not used by, dependents will not eventually be used to inter other veterans. If such a policy were to be adopted, however, this would in effect make the 6′x10′ gravesite system a 3′x10′ gravesite system with gravesites of equal size reserved for dependents—but able to be released for use by single veterans if not needed. Under such conditions the density of interments per gross acre would increase slightly, perhaps as much as 7%. This would not affect the cost effectiveness of Alternative 2 in any significant way but would introduce complex administrative problems.

(g) 3.5′x9.5′ Gravesite (3) Compared with 5′x10′ Gravesite (0)

Again our example will assume that both alternatives employ some sort of durable liner. The costs of land, site development and perpetual maintenance will be less for the 3.5′x9.5′ gravesite because it occupies 33.5% less land area. It will be assumed that there will no difference in interment productivity. Under these conditions, the smaller gravesite must be more cost effective.

A typical example would be:

Alternative 0	**Alternative 3**
PI = 170	PIX = 170
EI = 1.21	EI = 1.21
PI/EI = 140	PIX/EI = 140
Unit Cost Liners = $80	Unit Cost Liners = $80

From Table 10-5, by interpolating, LCC(0) = $428.50 and LCC(3) = $371.70.

The Cost Effectiveness Ratio of Alternative 3 compared with Alternative 0 is:

CER = LCC(0)/LCC(3) = $428.50/$371.70 = 1.15

The same result can be obtained graphically as shown in Figure 10.3.

Naturally the smaller gravesite is more cost effective. In real terms, in our typical example, a present value of $56.80 of life cycle cost savings per veteran family unit can be realized. There are limitations and disadvantages to the smaller gravesite, however, which were discussed in Chapter 5.

(h) Preplaced Double Depth Lawn Crypts (4) Compared with 5′x10′ Gravesites (0)

Our example will assume that the 5′x10′ gravesite employs some sort of durable liner. The costs of land, site development and perpetual maintenance will be less for the narrow preplaced double depth lawn crypt alternative because it occupies 51.6% less land area. In principle, Alternative 4 is only a slightly more dense example of Alternative 3. The real differences between them is that the interment productivity achievable under Alternative 4 is signficantly higher because of much less excavation per interment. Clearly, then, Alternative 4 will be more cost effective than Alternative 0 so long as a two-space crypt does not cost much more than 1.33 liners and markers (for the veteran and his dependents).

A typical example would be:

Alternative 0	**Alternative 4**
PI = 170	Unit Cost – Crypt and Marker Installed = $340
EI = 1.21	
PI/EI = 140	
Unit Cost Liners = $80	

From Table 10-5, by interpolating, LCC(0) = $428.50 and LCC(4) = $425.20.

The Cost Effectiveness Ratio of Alternative 4 compared with Alternative 0 is:

CER = LCC(0)/LCC(4) = $428.50/$425.20 = 1.01.

The same result can be obtained graphically as shown in Figure 10.4.

If the productivity rate of Alternative 0 had been 121 instead of 170, the CER would have been 1.12 whereas, if the productivity rate had been 242, the CER would have been 0.91. What this means, in general, is that preplaced double depth crypts are likely to be cost effective in cemeteries where environmental and operational conditions result in a productivity rate lower than average for the National Cemetery System (using 5′x10′ gravesites with liners). On the other hand, in existing cemeteries where the productivity rate exceeds the average for the National Cemetery System, it is not likely that lawn crypts can be constructed cost effectively unless local construction market conditions permit the crypts to be purchased very economically, say for $300 or less including the marker.

In making the above comparison it has been assumed that the 33% (⅔ of 50%) of crypt spaces normally not used by the dependents will not be reclaimed for interments of single veterans. If they were, the Cost Effectiveness Ratio of Alternative 4 would increase.

(i) Garden Crypts (5) Compared with 5′x10′ Gravesites (0)

Our example will assume that the 5′x10′ gravesite employs some sort of durable liner. The costs of land and site development will be less for the prototype design of garden crypts because they occupy 69.0% less land area. The cost of maintenance and interment also will be significantly less for garden crypts but the cost of construction will be significantly higher—in fact much higher under the best of circumstances.

A typical example would be:

Alternative 0	**Alternative 5**
PI = 170	Unit Cost – Crypt Installed = $500
EI = 1.21	
PI/EI = 140	
Unit Cost Liner = $80	
PM = 4	

From Table 10-5, by interpolating, LCC(0) = $428.50, the adjustment to present value is + $30.40, and LCC(5) = $684.10.

The Cost Effectiveness Ratio of Alternative 5 compared with Alternative 0 is:

$$CER = LCC(0)/LCC(5) = \$458.90/\$684.10 = 0.67$$

The same result can be obtained graphically as shown in Figure 10.5. It would currently have to be possible to construct the crypts, plus associated special site work, for $300 or less per garden crypt to be more cost effective than using 5′x10′ gravesites in cemeteries having average productivity. The only condition under which we can visualize that occurring is if a schematic design based on the use of reusable crypt forms were developed, a performance specification allowing wide choices of materials were prepared, and design-build bids were taken with the stipulation that only bids resulting in a unit cost, say of $300 per crypt or less would be considered; even then, such a unit price might not be currently achievable.

Clearly, one would have to resort to preplaced lawn crypts before considering garden crypts to extend the life of a closing cemetery (by developing higher densities). On the other hand, if an area of cemetery is too steep for normal inground burials it could conceivably be as cost effective to construct garden crypts benched into those slopes as it would be to construct lawn crypts terraced into the slope—for the reason that in the first instance there would be a tradeoff of facing and normal wall construction against the need to construct the rear walls as retaining walls while, in the second instance, the terracing walls would be purely add-on costs. The costs in each case would be greatly dependent on the specific site conditions. Either case could be considered cost effective in any cemetery that was in its closing decade when compared to having no gravesites in the highly sloped areas as the alternative—unless a new national cemetery were going to be constructed in that area during that decade.

(j) Columbaria Walls (7) Compared with Inground Cremains Interment (6)

The control alternative for comparing the cost effectiveness of cremains interment is inground—using half of a standard grave obstructed by a tree, utility line or appurtenance, etc. The 5'x5' plot provides burial space for the entire veteran family unit. Alternative 7 as illustrated in Figure 5.11 is a gardenesque approach to providing an area for freestanding columbaria walls. Much higher densities can be achieved through design. Nevertheless, its costs of land and site development will be less than for Alternative 6 because it occupies 51.2% less land area per veteran family unit. Maintenance costs will be somewhat less but the cost of construction will be very much higher.

A typical example would be to compare a columbaria wall with niches costing $140 each with inground interment where the maintenance productivity rate is 6 acres/yr/employee. From Table 10-5 LCC(6) = $152.20 and LCC(7) = $175.30.

The Cost Effectiveness Ratio of Alternative 7 compared with Alternative 6 is:

CER = LCC(6)/LCC(7) = $152.20/$175.30 = 0.87

The same result can be obtained graphically as shown in Figure 10.6.

Columbaria walls would not be cost effective unless they could be constructed for about $120 per niche or less. This may be possible if they are designed in structures holding a great number of niches and using remote memorialization similar to the crypts in Alternative 5. That would permit low facing and foundation costs per niche and very high densities. Even then, on economic grounds alone one would not be justified in constructing columbaria walls until all the obstructed inground gravesites had been used up, since the costs of developing and maintaining those areas would have otherwise to be borne without deriving any interment benefit.

(k) Add-On Columbaria Niches (8) Compared with Inground Cremains Interment (6)

The comparison here is the same as in Alternative 7 except that the columbaria niches are added on to a structure (building or wall) that is needed for some other purpose. For this reason we have assigned no land or site development costs to Alternative 8. Also the cost of construction is relatively low. In most cases the structure to which the niches are added will have no additional foundation costs and usually will already have been planned to be clad with a stone suitable for conversion to a niche face stone.

A typical example would be to compare add-on niches costing $50 each with inground interment where the maintenance productivity rate is 6 acres/man-year. From Table 10-5 LCC(6) = $152.20 and LCC(8) = $79.00.

The Cost Effectiveness Ratio of Alternative 8 compared with Alternative 6 is:

CER = LCC(6)/LCC(8) = $152.20/$79.00 = 1.93

Obviously this method of providing for interments of cremains is very cost effective.

However, $99.50 of the $152.20 cost related to inground interment is for land, site development and perpetual maintenance. These costs are incurred whether or not the above ground niches are constructed. Accordingly, it ordinarily will not be economically justified to construct add-on columbaria niches unless it is estimated that the number of cremains interments required for a particular cemetery will exceed the number of suitable obstructed gravesites that will occur during its development.

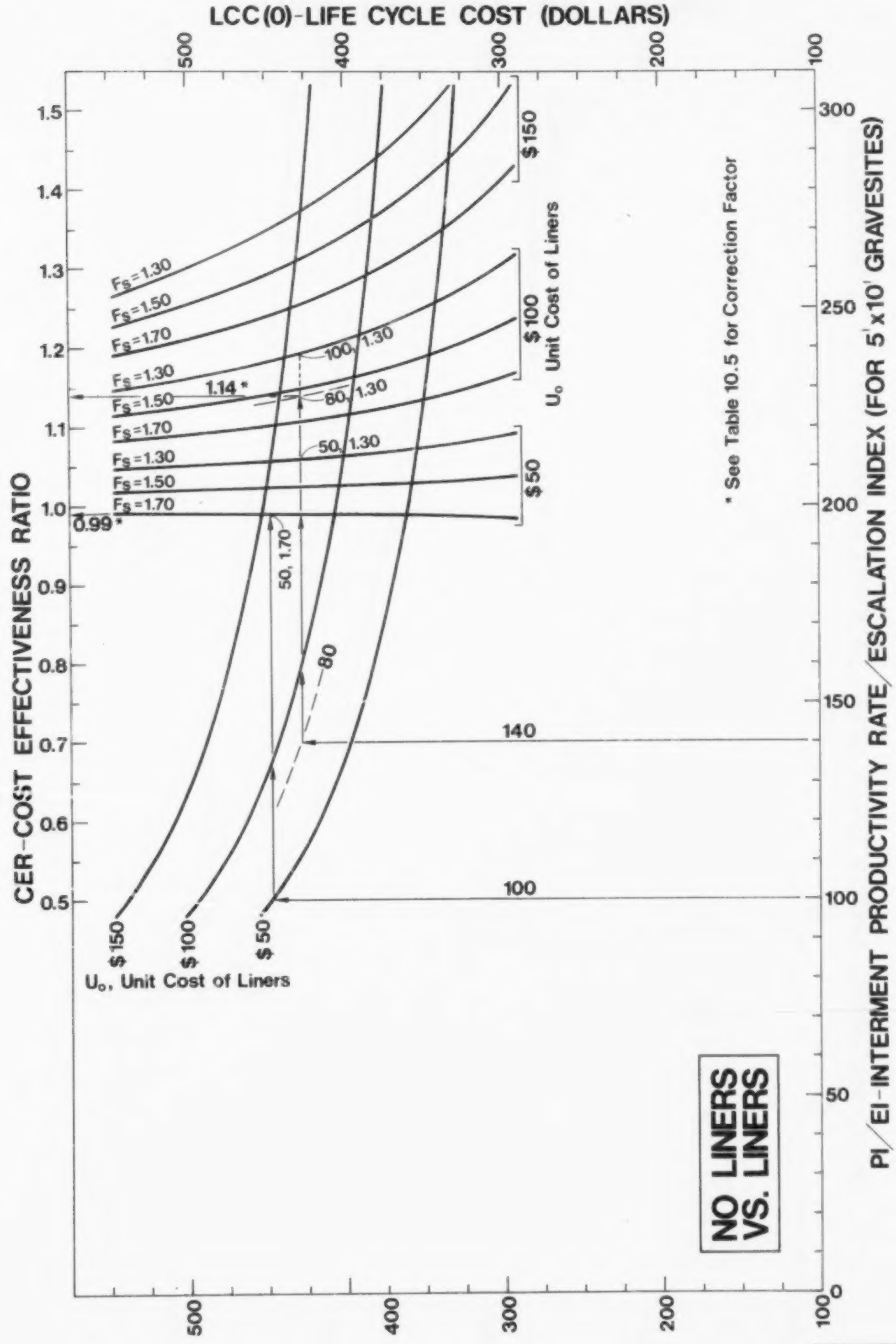
LCC(0)-LIFE CYCLE COST (DOLLARS)
500
400
300
200
100
CER-COST EFFECTIVENESS RATIO
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.99*
1.14*
Fs=1.30
Fs=1.50
Fs=1.70
Fs=1.30
Fs=1.50
Fs=1.70
Fs=1.30
Fs=1.50
Fs=1.70
100, 1.30
80, 1.30
50, 1.30
50, 1.70
80
140
100
$150
$100
$50
Uo Unit Cost of Liners
$150
$100
$50
Uo, Unit Cost of Liners
* See Table 10.5 for Correction Factor
NO LINERS VS. LINERS
PI/EI-INTERMENT PRODUCTIVITY RATE/ESCALATION INDEX (FOR 5'x10' GRAVESITES)
300
250
200
150
100
50
0
500
400
300
200
100

Figure 10.1

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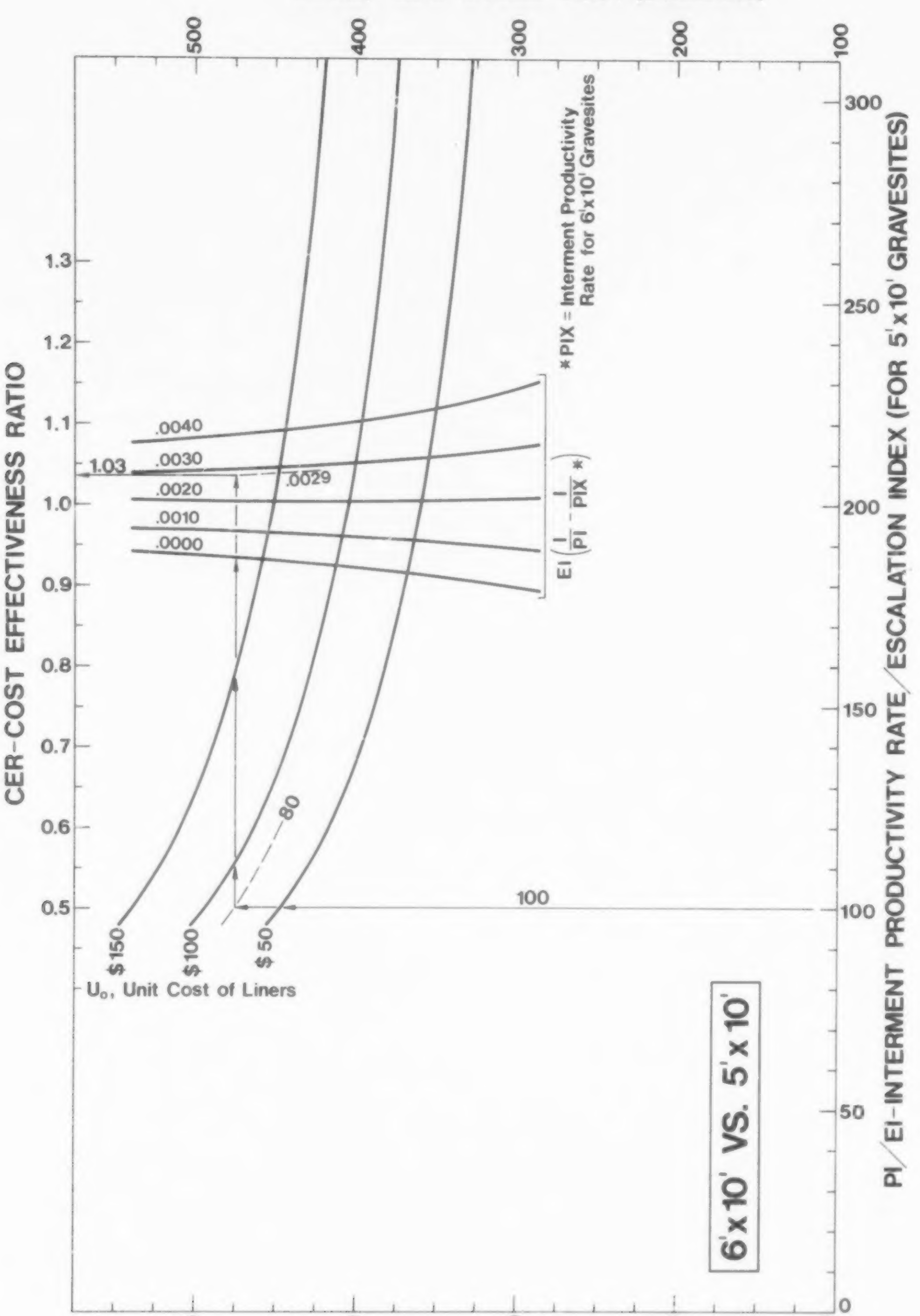
LCC(0) LIFE CYCLE COST (DOLLARS)
500
400
300
200
100
CER-COST EFFECTIVENESS RATIO
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.03
.0040
.0030
.0020
.0010
.0000
.0029
EI (1/PI − 1/PIX *)
* PIX = Interment Productivity Rate for 6'x10' Gravesites
$150
$100
$50
U₀, Unit Cost of Liners
80
100
PI/EI-INTERMENT PRODUCTIVITY RATE/ESCALATION INDEX (FOR 5'x10' GRAVESITES)
0
50
100
150
200
250
300
6'x10' VS. 5'x10'

Figure 10.2

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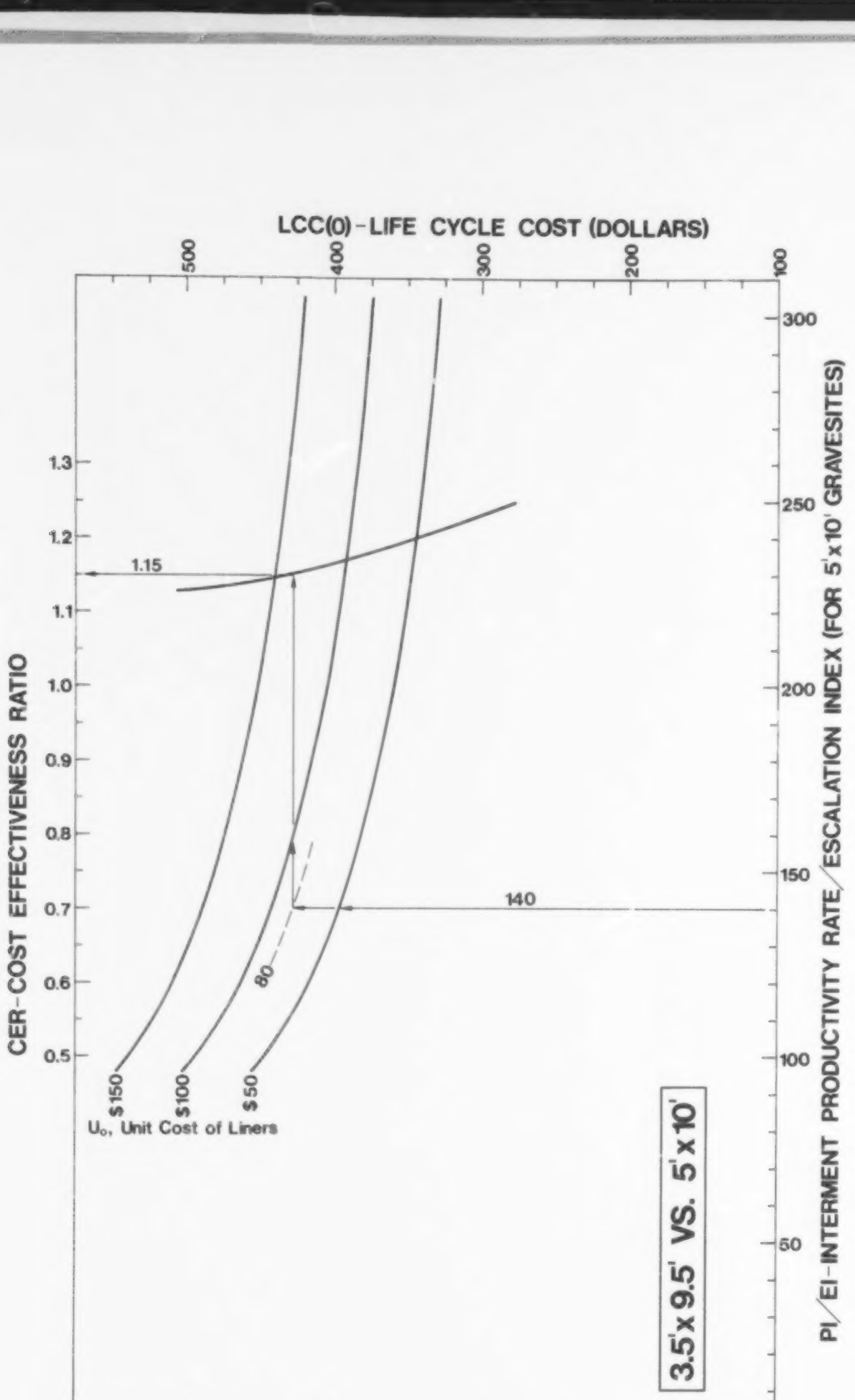
LCC(0) - LIFE CYCLE COST (DOLLARS)
500
400
300
200
100
CER-COST EFFECTIVENESS RATIO
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.15
140
80
PI/EI-INTERMENT PRODUCTIVITY RATE/ESCALATION INDEX (FOR 5'x10' GRAVESITES)
0
50
100
150
200
250
300
$150
$100
$50
U₀, Unit Cost of Liners
3.5'x9.5' VS. 5'x10'

Figure 10.3

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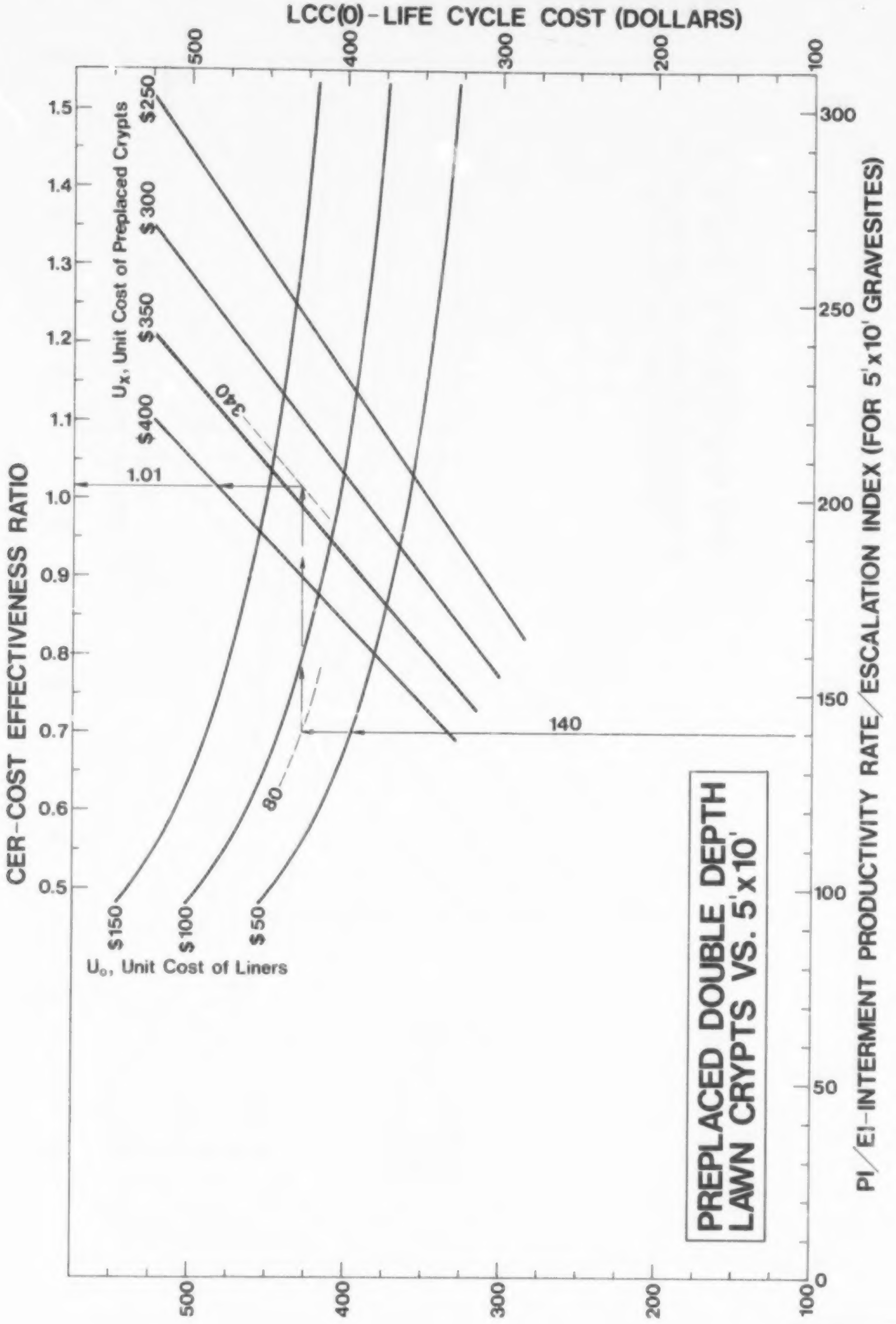
LCC(0) - LIFE CYCLE COST (DOLLARS)
500
400
300
200
100
CER-COST EFFECTIVENESS RATIO
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
PI/EI-INTERMENT PRODUCTIVITY RATE/ESCALATION INDEX (FOR 5'x10' GRAVESITES)
300
250
200
150
100
50
0
U_X, Unit Cost of Preplaced Crypts
$250
$300
$350
$400
$150
$100
$50
U_o, Unit Cost of Liners
1.01
140
340
80
PREPLACED DOUBLE DEPTH LAWN CRYPTS VS. 5'x10'

Figure 10.4

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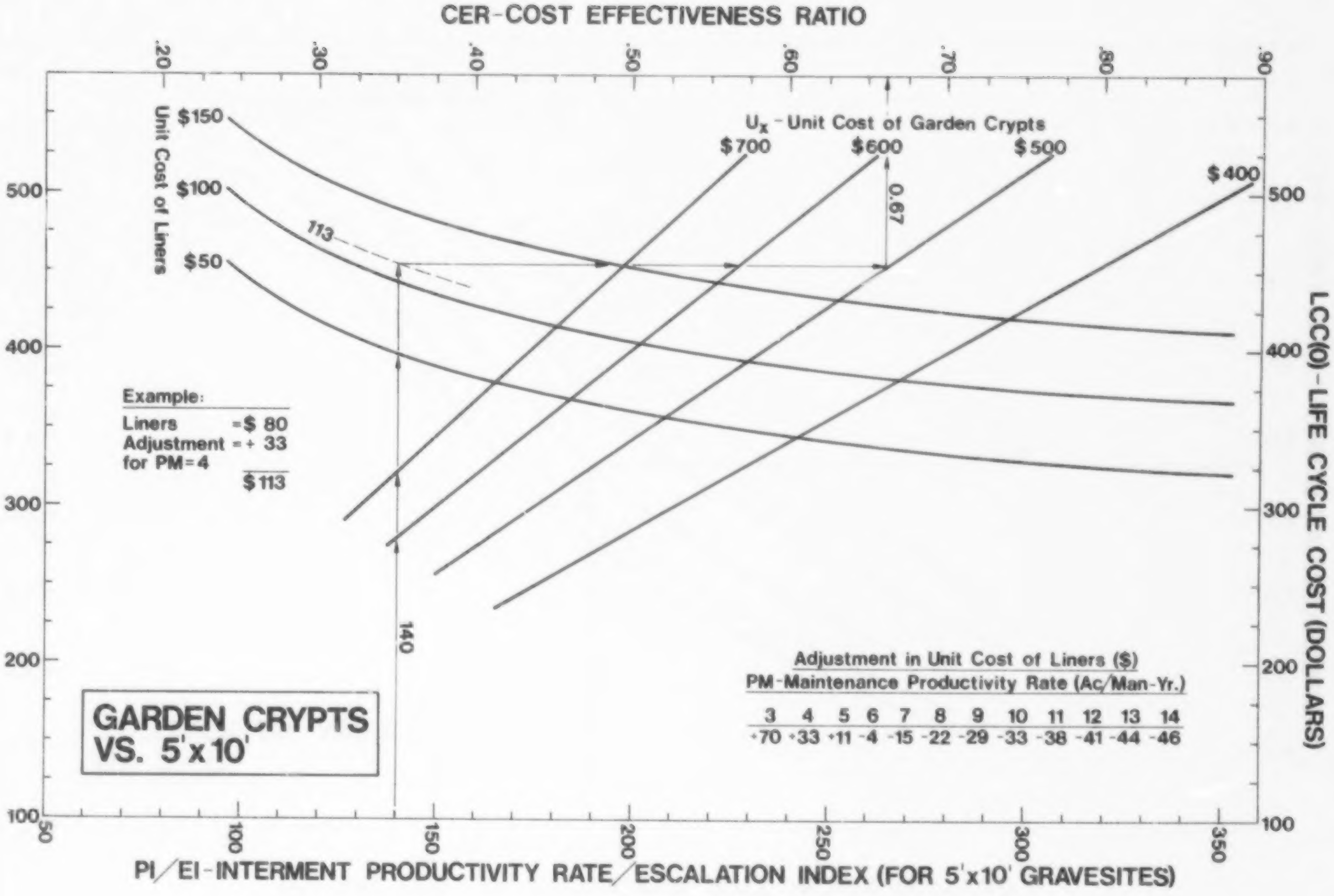

3	4	5	6	7	8	9	10	11	12	13	14
+70	+33	+11	-4	-15	-22	-29	-33	-38	-41	-44	-46

Figure 10.5

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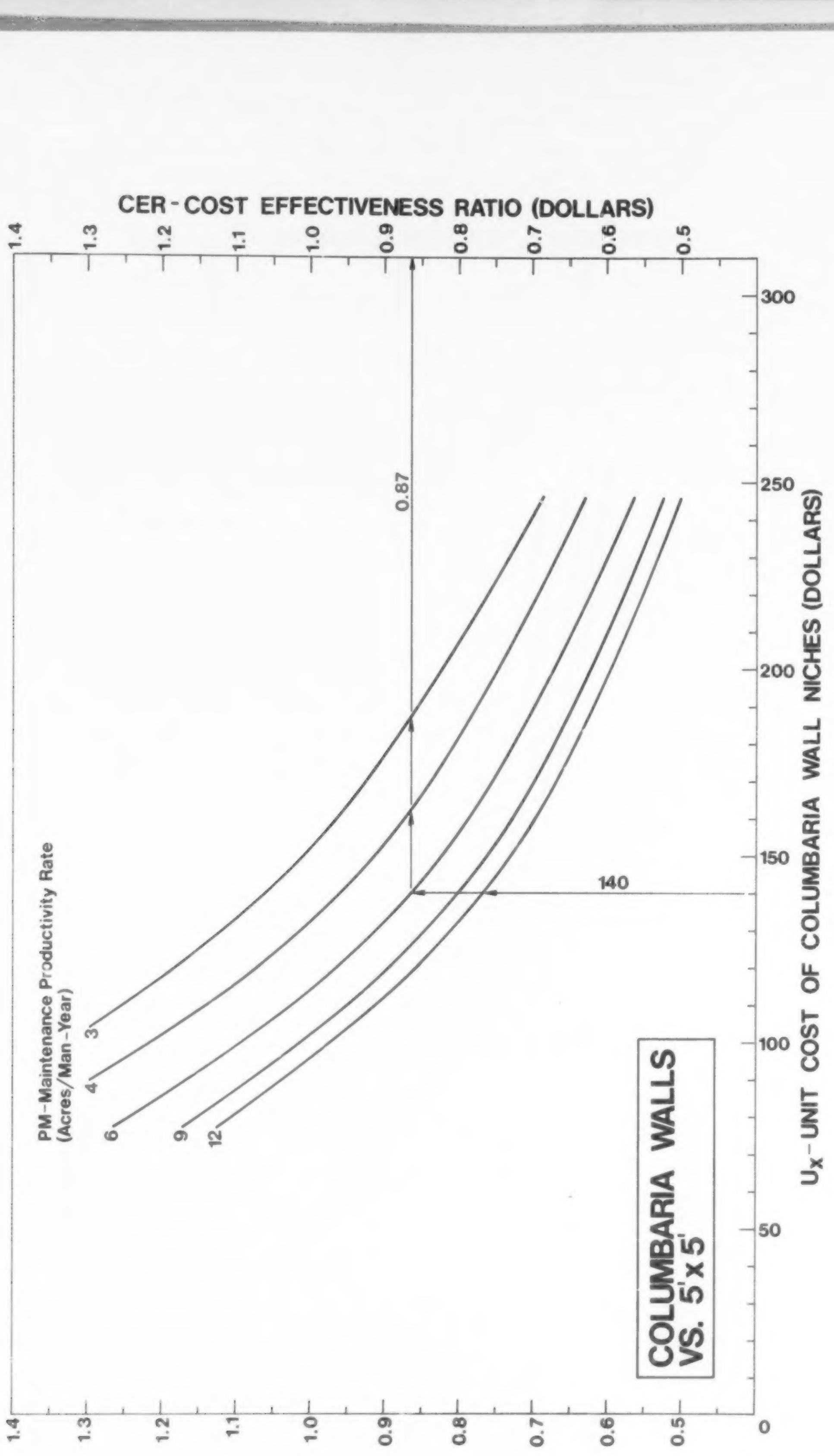
CER - COST EFFECTIVENESS RATIO (DOLLARS)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0
50
100
150
200
250
300
U_X - UNIT COST OF COLUMBARIA WALL NICHES (DOLLARS)
PM-Maintenance Productivity Rate
(Acres/Man-Year)
3
4
6
9
12
0.87
140
COLUMBARIA WALLS
VS. 5' x 5'

Figure 10.6

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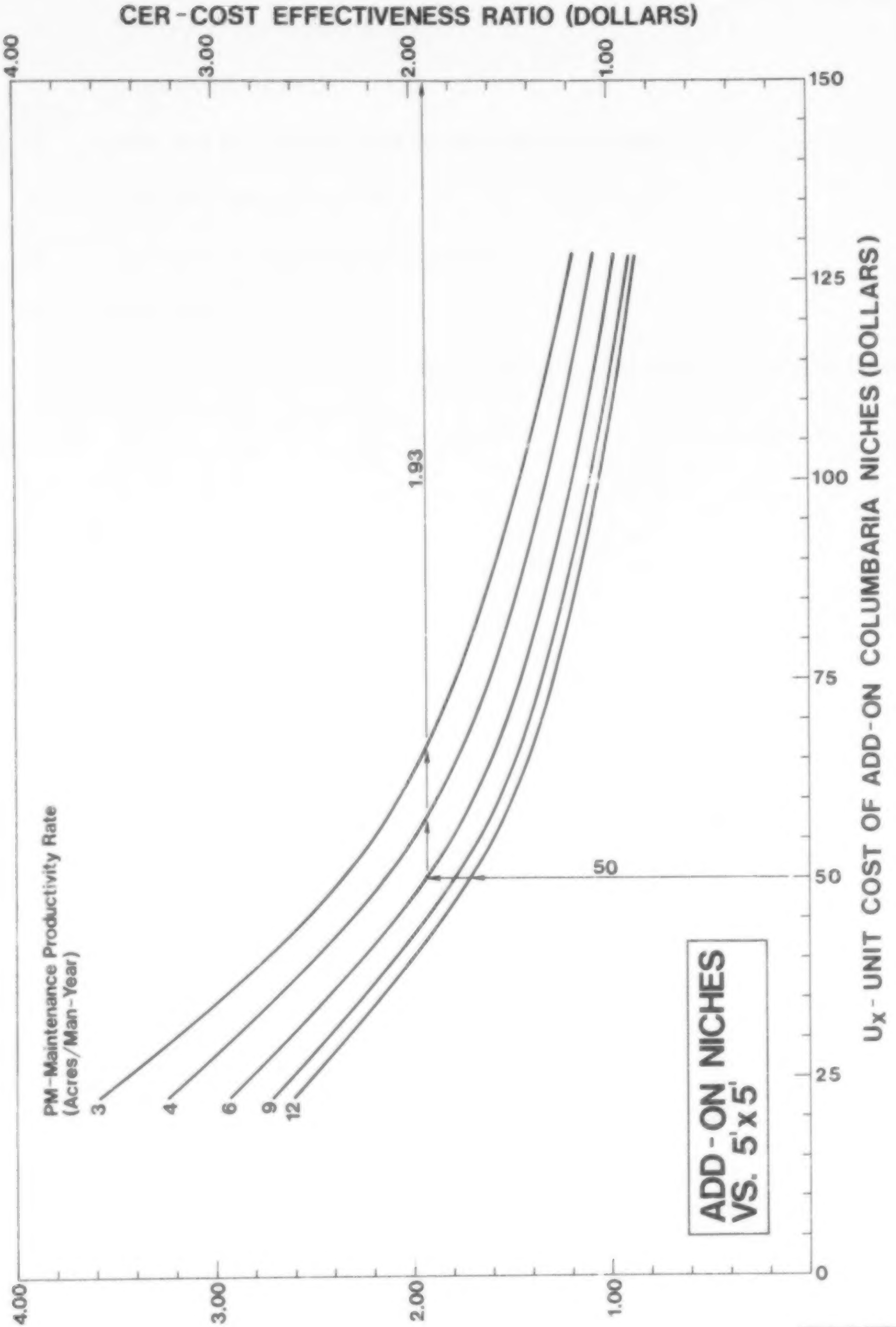
CER - COST EFFECTIVENESS RATIO (DOLLARS)
4.00
3.00
2.00
1.00
150
125
100
75
50
25
0
U_X - UNIT COST OF ADD-ON COLUMBARIA NICHES (DOLLARS)
PM-Maintenance Productivity Rate (Acres/Man-Year)
3
4
6
9
12
1.93
50
ADD-ON NICHES VS. 5'x5'

Figure 10.7

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APPENDICES

A Analysis of the Questionnaire

B Glossary of Terms

C Raw Data on Interment and Maintenance Unit Costs

D Table of Discount Factors

E Derivation of Approximate Equations

F References

G Forms for Analyses of Cost Effectiveness — Alternative Methods of Interment

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APPENDIX A

ANALYSIS OF THE QUESTIONNAIRE

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ANALYSIS OF THE QUESTIONNAIRE

General

A study of alternative methods of interment for national cemeteries required data that was both current and sufficient for analyzing the subject on a national basis. Several sources of information were immediately available in the records of the Veterans Administration's Central Office. Other data could be gathered through research. However, when it came to the details of expenditures and environmental factors related to any particular cemetery, it was realized that such information would have to come directly from the individual national cemeteries. In order to reach the most current data as quickly, efficiently and economically as possible it was decided that a detailed questionnaire be developed and sent to the directors of all national cemeteries throughout the country that had interments in 1978. A sample of that questionnaire can be found at the end of this appendix. The questionnaire was organized in two basic parts: one involved questions about the physical description of the cemetery, its environmental and interment methods; the other dealt with cost data and was further divided into costs for interments, maintenance and construction.

Seventy-seven (77) questionnaires were mailed on July 25, 1979. Sixty-two (62) forms were returned.

In general the resultant data has been satisfactory and readily adaptable for analysis and comparison but a few questions appear to have been misunderstood and some answers particularly on cost data could not be correlated with answers to other questions and with costs listed in the appendices to the questionnaire. Certain terminology was quite uniformly misinterpreted, such as the difference between land requiring maintenance (Question 1.05) and net gravesite areas (Question 1.06). Few appeared to understand question 1.09 which requested that the total number of interments be refined as to the sizes of gravesites. Many directors either misinterpreted the question or answered it with data for 1978 only. Accurate data about how many concrete liners have been used to date were virtually impossible to obtain because of the misunderstanding of question 1.09 and because of the difficulty in estimating the quantity of liners furnished by private individuals in the past. Information on soils, climate, terrain and irrigation was conscientiously documented.

The major problem which the questionnaire produced dealt with cost data. In the section on General Fiscal Data (Section 6) it was hoped that the total expenses for the fiscal year used would be shown, and then, that the answers to detailed questions in the following sections, added together, would equal the totals given in Section 6 or be reasonably close. However, the intent of questions 7.05 and 8.05, aimed at establishing the costs related to equipment maintenance, was almost universally misconstrued in the questionnaires returned. In order to resolve some of the confusing data, a number of cemeteries were reached by telephone. Still, this item of information was not completely clarified except to the extent that the telephone enquiries we made enabled us to make reasonable judgments of the costs of equipment maintenance.

Similarly, cemetery directors found it difficult to separate labor costs for interments from labor costs for maintenance since most cemeteries use the same personnel in both functions. Consequently, the information requested in Appendix A (labor costs for interment operations) and Appendix C (labor costs for grounds maintenance) was usually presented unseparated in one appendix or the other—ordinarily with an explanation that "everyone has to do everything" or with a vague estimate of the breakdown. We resolved this difficulty by working back from Form 40.4991, the ungraded employee hour monthly operating report (MOR).

In this appendix we will appraise the results of the questionnaires by analyzing the twent cemeteries which we have selected for detailed study. Twenty of these are among the la and most active in the system, while two were picked at random from the vast majority of nat cemeteries with less than one burial a day.

(a) Location and Size

Section 1 on location and size has been discussed in Chapter 3 of this report along gravesite sizes. The answer to question 1.12 concerning the annual burial ra reflected in several portions of this study and is the basic data upon which the pro tivity rate for each cemetery was determined.

Question 1.13 requested data on the busiest month for interments: What month how many burials were made? As might be expected the two cemeteries which, in were having less than one interment per day had a more erratic pattern of mo burials. They averaged 16% of the annual burials in one busy month, one being M and the other May. All the other cemeteries had a maximum number of intermen one month ranging from 9 to 12 percent of the burial rate with a national avera 11.15%. Most of these occurred in the winter months: out of the twenty cemet seven listed January, three February, and two March. Geographical location had effect and the fact that more deaths occurred in the winter months on an ave follows a natural pattern.

The rate of reopeners in relation to the annual burial rate varies considerably from cemetery to another. It is understandable that cemeteries which are closed will ha high reopener rate. In the sample of 22 national cemeteries, four were closed. T had an average rate of reopeners of 51%. For the other 18 open cemeteries the dropped to an average of 13.3%. The average rate for all 22 was 20%. It would b pected that the rate of second burials would have a relationship with the rate of eli dependents of veterans interred. The national average of the percentage of depen related to total interments is 26% ±, somewhat higher than the reopener rate fou the study sample. This can best be explained by the fact that the majority of cemet not included (86) in the sample are already closed (46) or scheduled to be closed w the next ten years (18). Reopeners in these cemeteries averaged 28.8% or higher the average percentage of dependents interred. Therefore it appears that there fairly direct correlation between dependent interments and reopeners. For any g cemetery the rate of reopeners will tend to be lower in its early years of use and hi in its closing years.

(b) Soils and Excavation

Of the twenty-two cemeteries studied in detail seven have predominantly clayey s five have mostly loam, three reported clay and loam together while the other s listed sand or a mixture of sand with clay or loam. Although only three reporte presence of hard rock, which could not be easily removed by a backhoe, fi cemeteries indicated that they did encounter rock in degrees varying from 0.1% to of the graves dug during the year. Only four of the 15 cemeteries, however, had to with rock over 15% of the time. The principal differences reported in the cemet which encounter rock was the type of equipment used. Most cemeteries were ab use their standard equipment, primarily a backhoe, to remove the rock (14 out o Four cemeteries found they had to use more time-consuming methods such as drilling, jack hammering, using a pavement breaker or using bar and wedge techni

No cemetery reported that it had to blast to loosen the rock.

Cemeteries with soil problems, such as cave-ins or periods when the ground water enters the digging area and takes a long time to leach away, are numerous. Six reported that they had unstable soils but no ground water problems. An additional six had ground water problems but without unstable soil. Three had both problems. Those reporting a ground water problem stated they performed a dewatering operation using some form of suction pump. Of the nine cemeteries reporting unstable soils only three found the problem severe enough to require shoring.

Of the cemeteries studied half (or eleven) have frozen ground for at least one month during the year. One cemetery reported five full months of frozen ground, while the average is from some time in December to some time in March. Seven cemeteries find it necessary to pre-dig graves prior to the advent of the deep-freeze of winter when excavaton becomes almost impossible with normal equipment.

The depth of soil cover has been discussed in detail in Chapter 3. It need only be mentioned here that no cemetery director felt that the minimum soil cover depth established for his cemetery had resulted in any significant damage to the liner during maintenance or reopening operations.

The most significant problem facing cemeteries, private, public or military, is the persistent occurrences of grave collapses. Much attention has been given to this matter in this study and it need not be repeated here. Twenty-one cemeteries studied in detail reported that graves do settle; one reported virtually no settlements.

The duration of time before steps were taken to refill settled gravesites following interment varied from "as soon as possible" to six months later with the average being about three to four weeks. Four cemeteries acknowledged that they use water to assist in settling the backfill. Some counted on the next heavy rain to do the job before dressing up the final surface of the active gravesite area. Refilling of a sunken grave more than once is standard procedure in 15 out of the 22 cemeteries studied. Of those 15 the average number of times that a single sunken grave was corrected (refilled) was two and two-thirds times. All cemeteries indicated that tamping was done as a matter of course during backfill operations but only two found that it solved the settlement problem.

Cemeteries purchasing topsoil paid as much as $10 a cubic yard and as little as $2.20 although twelve cemeteries did not purchase topsoil. Most cemeteries stockpile topsoil on the cemetery grounds. Six cemeteries were bringing it in from off-site sources. Topsoil is spread to variable depths, 4" to 6" deep in the northern and eastern parts of the country and 2" to 3" in the south and west.

(c) Climate

In asking questions about climatic conditions which could presumably have a heavy impact on costs, we concentrated on winter weather. Thirteen of the 22 cemeteries reported at least one 3" snowfall a year, one had an average of 15 such snowfalls and the national average of the 13 cemeteries was 5 storms a year. Ten of these cemeteries found they had to remove snow from their active interment areas but only two devoted snow removal efforts to the completed grave areas.

Unusual climatic conditions which cemetery directors listed as making normal operations difficult covered a variety of elements and only four of the 22 cemeteries failed to mention at least one climatic problem. There evolved no special pattern from the answers but heavy rains or rainy seasons were the most widely reported.

(d) Terrain and Vegetation

Of the 22 cemeteries analyzed half can be considered as relatively flat having not more than 20% of its land sloping at more than a 5% gradient. Four cemeteries are gently rolling with 25-50% of its ground surface pitching over 5%; the remaining seven have a rather rugged terrain, two of these being on property that is totally over 15% grades.

In order to get a sense of the natural quality of the land on which the cemetery has been placed we asked what kind of vegetation exists on cemetery land yet to be developed and we asked about the relative wetness or dryness of the ground surface. Six cemeteries did not answer the first question which indicates that there is no adjacent cemetery property to be developed. One cemetery did not report on the surface conditions.

Vegetation varied from 85% mixed woodland to 100% open fields. Those with open fields over 80% or more of the undeveloped property were the most common (9 cemeteries). Five cemeteries reported a mixture of vegetation including at least two of the following types: scrubland, high grass, fields and woods of various age. One cemetery listed 100% scrub growth and one cemetery had 85% or more of woodland.

Soil moisture at the ground surface varied as one would expect. In the north and east and in the southeast cemeteries reported conditions were at least 75% moist or wet. In the southwest, with the exception of Sante Fe, N.M. and Los Angeles, CA, all cemeteries described the ground surface as 60% dry or drier. Four indicated conditions 100% dry and five had ground surface at least 98% moist. Two cemetery directors found conditions as extreme as to report 100% wet but without standing water. The remaining ten cemeteries reported varying degrees of moisture and aridity, usually some of both.

(e) Lawns and Irrigation

The questions asked in this section were directed toward maintenance of the grounds. We wanted to see if some cemeteries had any particular problems that may help us to understand why their maintenance costs were higher than the average. Or why some cemeteries may have had lower than average costs in 1978.

Time devoted to mowing and trimming was higher in almost all cemeteries where time spent on interments was higher. Of the 22 studied 17 listed more money spent on their grounds maintenance units than on their interments units. Since lawn maintenance is a large part of grounds maintenance we attempted to find out what reasons may have caused one cemetery to have a higher percentage of its labor costs for lawn care than the others. We asked how many times lawns are mowed per month and found out that most cemeteries (16) were mowing approximately once a week. A few (3) mow more frequently (six to eight times a month) and only two cemeteries were mowing less than once a week. The time devoted to trimming around markers relative to that spent on lawn mowing varied considerably, but since many reports excluded other grounds maintenance activities not defined, it was difficult to arrive at a conclusion. It is interesting, however, to note that there was an even split between those cemeteries spending more time for mowing and those spending more time trimming.

Only 8 of the 22 cemetery directors answered that they did not have an irrigation system. We can not be certain from the responses what type of irrigation is provided at those cemeteries where the director answered that they did have a system. Nine cemeteries in 1978 had 100% irrigation, two had at least 50% of the gravesites irrigated by a system and three had from 10 to 50% irrigated.

All cemeteries were using water in one way or another to supplement rainfall. Sixteen of the 22 cemeteries were paying for water anywhere from 27 cents per 1,000 gallons to $0.50 per cubic foot ($66.85 per 1,000 gallons). Some cemeteries had their own source of water which was used both as a primary source or as a supplement. Two had wells; one drew water from an adjacent lake and two others had ponds on the cemetery grounds. The amount of water used to irrigate lawns varied considerably as cemeteries with high annual precipitation rates would tend to use less water and vice versa for cemeteries in arid parts of the country. In fact 5 cemeteries of the 8 shown on Table 7-6 as having a high percipitation rate either did not answer this question or stated that no supplemental watering was used. Two of the other three answered that they placed about 4" per month per acre of irrigation water while one reported one inch per acre per month. Four of those 8 cemeteries which did not have an irrigation system reported that they used some other form of irrigation. Three use manual hose and sprinkler units and one has a water tank on a trailer.

The final question dealing with items describing the cemeteries asked for the percentage of lawns which burn out annually on an average. Most cemetery directors (16) answered that none of the lawns burn out while the others reported from 1 to 16% burn out occurred. This sampling is too insignificant to establish any kind of correlation between burned out lawns and the types or amounts of irrigation provided. Using the monthly operating reports (MOR) of the 22 cemeteries studied we found that all but three of these had reported some time devoted to either reseeding or resodding or both. How much of this work was induced by too little or too much irrigation we can not surmise. We can only report that burned out lawns do not seem to be a significant problem but repair to lawns for other reasons does increase the time spent by the grounds maintenance units.

Sections 6 through 9 of the questionnaire and appendices A through D concern fiscal data and costs which have been, we feel, sufficiently analyzed in Chapters 6 through 9 of this report.

In Section 10 of the questionnaire we asked for comments about the public reaction to the interment methods currently used at the national cemeteries. Two of the directors neglected to answer and one stated that there had been no public reaction. All the others had generally favorable comments. One cemetery noted that an occasional complaint came from some people that they did not like to see the casket transported to the gravesite area in a pickup truck. The only other negative response came from one director who noted that some people "did not like being buried one above the other".

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INTERMENT METHODS AND COST QUESTIONNAIRE

Data for fiscal year 1978 would be preferred if it is representative. If for some reason it is not representative, please use another fiscal year.

Please answer all questions for the same fiscal year selected below. Answers recording the number of completions, such as interments or gravesites, should be for the end of that fiscal year. We hope to obtain the most representative and the most current data for your cemetery. Include only data relating to your cemetery.

What fiscal year will you use?__________

If not 1978, why?____

1 - LOCATION AND SIZE

1.01 Name of Cemetery____

1.02 Address____

1.03 Name of Director____________________Tel.__________________

1.04 Total No. acres of land________________

1.05 Total No. acres of land (including roads, etc.) requiring grounds maintenance. Exclude all undeveloped natural areas.______________

1.06 Total No. acres of net gravesite areas already laid out for burials.

____

1.07 Total No. of in-ground gravesites already opened________________

a. No. directly in-ground or in concrete liners________________

b. No. in preplaced lawn crypts____________

1.08 What size gravesite do you currently use?_________ft. x_________ft.

1.09 List the total number and size of gravesites used, excluding sites for cremains:

No. of Gravesites	Length	Width	Typ. Depth 1st Burial	No. without concrete liners
________ were	________ ft. x	________ ft.	________ ft.	____________
________ were	________ ft. x	________ ft.	________ ft.	____________
________ were	________ ft. x	________ ft.	________ ft.	____________

1.10 How many gravesites used for cremated remains? ____________

Typical size ____________________

1.11 Total No. of first above-ground interments completed: ____________

a. No. in columbaria ____________

b. No. in mausoleums ____________

c. Other (Specify) ____________ ....

____

1.12 How many gravesites were opened in the year? ____________

1.13 How many gravesites were opened in the maximum month? ________

What was that month? ____________

1.14 How many openings in the year were first burials? ____________

1.15 How many were reopeners? ____________

1.16 What kind of grave markers do you use? Upright? ________ Flat? ____
If both indicate % each. Other? ____________________

1.17 What percentage of grave markers were furnished privately (not by government)? ________

a. Of those furnished privately what percent are:

Flat ________ % Upright ________ % Other ________ %

2 - SOILS AND EXCAVATION

2.01 How would you describe the soils that must be excavated at burial levels? Indicate the % of total cemetery you feel is occupied by each:

Description		Check Soils that are Difficult or Unstable
Coarse sand and gravel	____________ %	____________
Medium and fine sands	____________ %	____________
Loam	____________ %	____________
Clay	____________ %	____________
Soft Rock present	____________ %	____________
Hard Rock present	____________ %	____________
	100 %	

Please place an asterisk (*) after the description of soils encountered most frequently during the year covered by this questionnaire.

2.02 Do you encounter rock at all?________

a. What percentage of the graves dug during the year?__________%

b. How do you remove it? Rip with backhoe?__________

Bar and Wedge?________ Blast?________ Pick and shovel?_____

2.03 Do you encounter unstable soils or groundwater at burial levels?_____

Specify one or both____________________

a. How do you solve the problem? Shoring?_____ Dewatering?___

b. How Dewater?____________________

c. Other methods?__________ Specify__________

2.04 Does the ground ever become so frozen that you can not dig with normal excavating equipment?__________ Every year?__________
How many years out of each five year period?__________
From what date±__________ to what date±__________?

2.05 How do you excavate the frozen ground? Blast?________Pre-dig and temporarily backfill?______Specify____________________________

2.06 How much soil cover do you place over the topmost liner or casket in a grave? __________inches

2.07 For the type of soils you have, does this depth of cover result in any significant damage to the liner during maintenance and reopening operations?____________

a. If yes, do you believe more depth of cover would cure the problem?_________

How much total?__________inches

2.08 Does the soil backfilled into gravesites always settle?______________

2.09 How long do you wait before refilling the settled areas?____________

2.10 Do you use irrigation or any other method to accelerate settling?_____

Specify____

2.11 Is one refilling of the settled area sufficient?______Or do you find you have to refill twice?______If more, how many times?____________

2.12 Have you ever attemtped to tamp the backfill to minimize settlement?___

a. If yes, did it remove the problem?_________

b. If you have not attempted to tamp the backfill, what was the reason for that decision?______________________________

2.13 Do you have stockpiled topsoil from cemetery construction which you respread?__________

2.14 Do you purchase any part of the topsoil you use?_________

a. If yes, what do you pay per cubic yard?____________Do you have to hand rake it?_________

2.15 How deep do you spread the topsoil?___________________inches

2.16 Where do you dispose of excess excavated soil?

a. Do you fill depressions?________________

b. Sell it?________At what price per cu. yd.?__________

c. Let contractors take it away at no cost?______________

d. Pay for it to be hauled away?_________At what price per cu.yd.?

____

3 - CLIMATE

3.01 How many snowfalls of more than 3 inches in an average winter?______

3.02 Within the last five years what do you estimate was the heaviest snowfall?____________inches

3.03 Do you normally have to remove snow prior to excavating or burial?____
If yes, how many days average each winter?___________

3.04 Do you remove snow from completed grave areas in winter?___________

How many days average each winter?__________

3.05 Please indicate any unusual prevailing climatic condition that makes your normal operations difficult:__________________________________

____

4 - TERRAIN AND VEGETATION

Please indicate your estimate in percentages of the best description of terrain within the cemetery boundaries. Please circle the number(s) indicating the slope condition(s) and surface moisture condition(s) that best represented conditions during the fiscal year you are using.

4.01 Slopes

1.	Slopes	0 - 5%	%
2.	Slopes	5 - 10%	%
3.	Slopes	10 - 15%	%
4.	Slopes	15% or steeper	%
			100 %

4.02 Vegetation (undeveloped areas)

1. open field %
2. scrub growth %
3. second growth woodland %
4. mature woodland %
5. high grass %

100%

4.03 Surface Moisture

1. dry (desertlike condition) %
2. normally moist %
3. wet but no standing water %
4. standing water (ponds, etc.) %
5. other (specify)____________________ %

100%

5 - LAWNS AND IRRIGATION

5.01 How frequently must you mow lawns during the growing season?
__________times per month

5.02 What % of total lawn care manpower is devoted to mowing?________
To trimming?__________

5.03 Do you have an irrigation system?______Over what % of total cemetery
developed to date?________% Do you pay for water?________
How much per 1000 gals? $__________ Do you have your own water
supply?______Wells?________Ponds?________Other________?
Specify________________How many inches or gallons per acre
per month do you apply?________inches________gallons per acre

5.04 If you do not have an irrigation system do you ever irrigate by other means?______ How?____________ How frequently__________?

5.05 What % of your total lawns burn out annually on the average and have to be reestablished?________

6 - GENERAL FISCAL DATA

The remainder of this questionnaire has to do with costs and factors affecting cost.

6.01 What was the total cost, including any contract costs, for the year, of the following activities:

Office of the Director and Administrative Branch	$__________
Equipment Maintenance Section	$__________
Operations Section	
Interment Unit....................	$__________
Headstone Unit...................	$__________
Maintenance Section	
Grounds Maintenance Unit..........	$__________
Facilities Maintenance Unit.........	$__________
Total	$__________

6.02 Check which of the following costs are included in the above amounts?

Wages______
Taxes and Benefits__________
Equipment____________
Fuel______________
Materials____________
Other________________ Specify____________

7 - COST OF INTERMENTS

7.01 How many cemetery employees were involved in interment and headstone operations?__________

a. Do you contract out for any of the interment or headstone operations?_________

b. If any, list the contracts (tasks) and their costs.

____

____

____

7.02 Please attach list indicating the number of cemetery employees in each salary classification and their salaries, in the form of Appendix A.

7.03 Do you own all your interment and headstone equipment?___________

7.04 What is the estimated annual straight line depreciation cost of the equipment you own, arrived at by dividing its purchase price by your estimate of its actual useful life--in the form of Appendix B. If you rent any equipment, please include in Appendix B the types and rental rates you pay.

7.05 Please estimate the year's cost of fueling and maintaining vehicles and equipment assigned to interment and headstone operations (including the appropriate share of operating the equipment maintenance section).

$_________Fuel, etc.)+ $__________(Salaries,excluding benefits)

7.06 If you purchase topsoil, what was the year's cost? $______________

7.07* Please estimate the year's cost (labor and equipment) of spreading topsoil on new gravesites areas completed? $____________, Equipment + $________________(Salaries excluding benefits)

7.08 Please estimate the annual cost of seed, grass plugs, sod, fertilizer, lime and other soil amendments devoted to establishing lawns at new gravesites during the year $_______________

7.09* What was the year's cost for markers?_______________

7.10* Please estimate the year's cost of lumber for temporary grave excavation covers and all other miscellaneous materials required for interment and headstone operations. $________________

7.11* Were there any special costs associated with rock removal, such as special drilling equipment, powder, etc.?________ Please estimate the approximate year's cost$____________________

7.12* Please estimate the approximate additional year's cost in labor, equipment and materials related to excavating during frozen periods. This should be done by determining what costs you would not incur if you had mild winters. $______________ Explain:____________________

____

7.13 Do you purchase precast concrete liners?________ Other?____________

a. What is the cost per unit?________________ Does this include the cost of setting them in place?________ Do you place them?_____

b. For how long does a supply contract run?____________ months

7.14 What factors most strongly determine the size of your operations staff required for interments? Rank in order of importance (1, 2, 3, etc.) Please add as many factors as you feel are important.

_______________ Annual number of interments

_______________ Difficulty of excavating during winter

_______________ Difficulty of excavating because of soil type or rock

_______________ ....

_______________ ....

* Exclude any contract costs. Include only costs incurred for work performed by cemetery employees.

8 - COST OF MAINTENANCE

8.01 How many cemetery employees were involved in grounds maintenance operations?________

a. Do you contract out for any of the grounds maintenance operations?

____

b. If any list the contracts (tasks) and their costs.

____

____

____

8.02 Please attach list indicating the number of cemetery employees in each salary classification and their salaries, in the form of Appendix C.

8.03 Do you own all your maintenance equipment?________

8.04 What is the estimated straight line annual depreciation cost of the equipment you own, arrived at by dividing its purchase price by your estimate of its actual life--in the form of Appendix D? If you rent any equipment, please include in Appendix D the types and rental rates you pay.

8.05* Please estimate the year's cost of fueling and maintaining vehicles and equipment assigned to maintenance operations (including the appropriate share of operating the equipment maintenance section).

$__________(Fuel, etc.) + $__________(Salaries, excluding benefits)

8.06* Please estimate the year's cost of fertilizer, lime, insecticides, and fungicides used in routine lawn, tree and shrub care. $__________

8.07* Please estimate the year's cost of all other materials necessary for grounds maintenance. $__________

8.08 Do you purchase any special service annually in connection with lawn, tree and shrub care?________Specify______________________

____________________ Please estimate the annual cost. $________

8.09* Please estimate a typical year's cost of reestablishing lawns that burned out. $__________(Materials, equipment)+ $__________(Salaries excluding benefits)

8.10 If reestablishing burned out or deteriorated lawns was less demanding, could your staff have been reduced?________How many manhours

for the year?__________

8.11 Do you currently experience sinkages?________

Specify reason ____________________________________

8.12 Have you ever in the past 10 years experienced more severe sinkage problems than currently?________ Specify reason ____________________

____

8.13* How many manhours per year were devoted to restoring sunken gravesites during the year?____________ In the worst year of the last 10 years if the problem has been more severe?__________

8.14* Please estimate the year's cost (labor, equipment and materials) for filling in sinkages $____________(Equipment and materials)

+ $____________(Salaries, excluding benefits)

How many gravesites were involved?____________________

* Exclude any contract costs. Include only costs incurred for work performed by cemetery employees.

9 - COST OF CONSTRUCTION

9.01 What is the current cost of purchasing land in your area, similar to that on which the cemetery is situated? $____________/Acre

9.02 What was the total cost of constructing the last section of cemetery (at least 5 acres or more) opened for interments? $__________________

How many gross acres?__________ What year constructed?__________

9.03 Do you have any columbaria niches constructed?__________

How many?__________ What was the cost of constructing the latest group?_____________ What year?__________ How many?__________

9.04 If you have no columbaria constructed, can you estimate the average current unit cost for private cemeteries in your area to construct columbaria niches? $__________ Are they granite clad?____________

Other surface treatment?_______ Specify_________________________

9.05 Do you have any mausoleum vaults constructed?________________

How many?__________ What was the cost of constructing the latest

group?_____________ What year?________ How many?________

9.06 If you have no mausoleum vaults constructed, can you estimate the average current unit cost for private cemeteries in your area to construct mausoleum vaults? $__________ Are they granite clad?________

Other surface treatment?________ Specify____________________

9.07 Do you have any preplaced lawn crypts constructed? ____________

Precast?__________ How many grave sites?____________________

What is the estimated total current cost of either purchasing and installing or constructing (underline one) a preplaced crypt per gravesite? $_______________

9.08 If you have no preplaced crypts constructed, can you estimate the average current cost for private cemeteries in your area to construct preplaced crypts per gravesite?_______________ Which type is used most? Precast?______ Cast-in-place?________ Why?____________

____

10 - PUBLIC ACCEPTANCE

10.01 What has the public reaction been to the interment methods used in your cemetery? Please attach your comments.

Prepared by:

____________________________________ Date: ____________________

Appendix A

Operations Wages for Fiscal Year 197__

Task Description	Classification	No. Personnel	Annual* Salary	Annual** Totals

Operations-Annual Total ________

---

* If employees worked less than a year please mark their annual salary with an asterisk(*).

** This should be the actual gross wages paid, whether or not the employee worked a full year.

Appendix B

Annual Cost of Operations Equipment for Fiscal Year 197_

Equipment Description	No.	Purchase* Price/Each	Estimated Useful Life	Total Annual Cost**

Annual Cost of Owned Equipment $__________

Annual Cost of Rented Equipment $__________

Total Annual Cost of Operations Equipment $__________

* Use either the original purchase price if the equipment is less than 3 years old or your best estimate of what the purchase price would have been in the fiscal year you are using.

** No. x Purchase Price ÷ Est. Useful Life

Appendix C

Maintenance Wages for Fiscal Year 197_

Task Description	Classification	No. Personnel	Annual* Salary	Annual** Totals

Maintenance Annual Total ________

* If employees worked less than a year please mark their annual salary with an asterisk (*).

** This should be the actual gross wages paid, whether or not the employee worked a full year.

Appendix D

Annual Cost of Maintenance Equipment for Fiscal Year 197_

Equipment Description	No.	Purchase* Price/Each	Estimated Useful Life	Total Annual Cost**
			yrs.	

Annual Cost of Owned Equipment $________

Annual Cost of Rented Equipment $________

Total Annual Cost of Maintenance Equipment $________

* Use either the original purchase price if the equipment is less than 3 years old or your best estimate of what the purchase price would have been in the fiscal year you are using.

** No. x Purchase Price ÷ Est. Useful Life

APPENDIX B

GLOSSARY OF TERMS

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GLOSSARY OF TERMS

Adjusted maintained acres — The number of gross acres of cemetery already developed into occupied gravesites with markers plus one half of the number of additional gross acres not so developed but having to be maintained in lawn.

Average — When used in a statistical sense, the arithmetic mean.

Burial Unit — A unit of reserved space within an interment structure for casketed or cremated remains. For the purposes of this report, this refers either to a casket site, or crypt space, within a garden crypt structure or to a niche designed to receive two or more cremated remains.

Cemetery director — The person with immediate responsibility for managing a national cemetery and for supervising all cemetery employees.

Closed active cemetery — A national cemetery containing only reserved or occupied gravesites in which interments are being made. Only those persons holding gravesite reservations and the spouses and dependent children of persons already buried in that cemetery may be buried in a closed cemetery.

Closed inactive cemetery — A national cemetery in which no interments are being made. Usually these are small Civil War Era cemeteries containing neither new nor reserved gravesites.

Collapse — A term used to describe the sinking of the surface of a gravesite when the casket has deteriorated to the point where the soil above caves in on the casket in whole or in part.

Columbarium (plural - baria) — A structure (e.g., building or wall) containing recesses or niches in which are placed cremated remains.

Cremains — Cremated remains; ashes of the dead.

Discount factor — The factor for any specific discount rate which translates expected cost or benefit in any specific future year into its present value. The discount factor is equal to $1/(1+r)^t$, where r is the discount rate and t is the number of years since the date of initiation, renewal, or expansion of a program or project.

Discount rate — The interest rate used in calculating the present value of expected yearly costs and benefits.

Garden crypt — A burial unit, or casket site, within an above ground interment structure (also referred to as a garden crypt) that contains a large number of such casket sites. When public access to the crypt faces is available, it is from the outdoors—although sometimes with overhead shelter. Garden crypt structures in the typical case are clad in stone and are placed in a gardenesque setting.

Gravesite — The space reserved for interring the remains of one or more persons, currently a veteran and all his eligible dependents. For the purposes of this report, gravesites shall mean inground or below ground volumes of space reserved for interment purposes.

Gross Acres — The total acreage of cemetery land already developed for gravesites—including, in addition to gravesite areas, all roads, buildings, buffer areas, or bodies of water within the developed cemetery boundaries but excluding areas of cemetery-owned land undeveloped and left in their natural state.

Interment — The act of interring casketed or cremated remains. For the purposes of this report, it refers to the collective acts required to prepare the interment site, transport the remains from the location of the committal service, place the remains in the grave or burial unit, close the grave, finally dress any disturbed area, and install a memorial marker or inscription.

Interment rate — The average number of burials per unit of time, usually per workday or per fiscal year.

Interment structure — Any precast, prefabricated or cast-in-place container, crypt or niche made of durable, rigid materials into which casketed or cremated remains are placed for interment purposes, either above or below ground.

Liner — A rigid container into which a casket is placed, or which is placed over the casket. It is designed to remain intact after the casket deteriorates thereby preventing the surface of the grave from sinking.

Mausoleum — A building or other structure, customarily of monumental stone construction, for the entombment of casketed remains and usually with access to the face of crypts from inside the building.

Memorialization — This term as used refers to any system designed to mark or record the names and other data pertaining to those already interred in gravesites or interment structures.

Net acres — The acreage specifically used for interments, that is, the number of gross acres less the acreage not specifically used for interments such as roads, buffer areas, buildings, ponds and the like. For inground interments net acres usually means just the area actually lined out for gravesites. For above ground interments net acres would mean the area disturbed in order to construct the interment structures and all special site work specifically required in connection with those structures.

Open cemetery — A national cemetery containing new gravesites in which interments are being made. Any eligible person may be buried in an open cemetery.

Present value cost — Each year's expected yearly cost multiplied by its discount factor and then summed over all years of the planning period.

Productivity rate — For interments, the number of annual interments divided by the number of man-years devoted to interments and headstone setting, expressed as annual interments per interment employee or per man-year. For maintenance, it is the number of adjusted maintained acres divided by the number of man-years devoted to maintenance activities less the number of man-years devoted to sinkage repair activities, expressed as maintained acres per maintenance employee or per man-year.

Reserved gravesite — A burial plot which is reserved for a specific individual. From 1947 to 1962, a gravesite adjoining one used for the interment of an eligible person was reserved for the future interment of the surviving spouse and eligible dependents.

Sinkage — A gradual settling or sudden collapse of the soil cover at the surface of an occupied inground gravesite due either to consolidation of the soil above or around a casket or liner or to physical collapse of a non-durable casket or liner.

Sinkage factor — The total number of manhours required to be devoted to all maintenance including sinkage repairs, divided by the number of manhours devoted to routine maintenance, excluding sinkage repairs. The man hours of sinkage repairs shall be the estimated manhours required to repair all sinkages that occur in a given year and include the functions of refilling graves, realigning headstones and reseeding or resodding graves.

Vault — A waterproof, airtight, interment receptacle which is designed to impede the deterioration of the casket and its contents but which also prevents the collapse of the grave when the casket eventually deteriorates.

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APPENDIX C

RAW DATA ON INTERMENT AND MAINTENANCE UNIT COSTS

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RAW DATA ON INTERMENT AND MAINTENANCE UNIT COSTS

ITEM	DESCRIPTION	CEMETERY CODE NO. CA-1	CA-2	CA-3	CO-1	FL-1
	INTERMENT					
1	Salaries	91,104	43,600	14,300	166,200	43,194
2	Benefits	10,021	4,796	1,573	18,282	4,751
3	Contract Costs	0	0	0	0	0
4	Equipment Costs	14,333	3,977	4,526	15,300	5,424
5	Equipment Maintenance (Mat'ls.)	4,800	450	3,760	8,100	1,118
6	Materials: Topsoil	60,000	800	1,533	0	0
	Seed, Fertilizer	30,000	0	4,929	5,500	0
	Lumber, etc.	2,500	250	0	600	300
7	Cost of Interments	212,758	53,873	30,621	213,982	54,787
8	Total Inground Interments	1,173	512	194	1,477	547
9	Cost of Interments/Gravesite	181	105	158	145	100
	MAINTENANCE					
1	Salaries	600,405	193,919	427,400	150,880	81,522
2	Benefits	66,045	21,331	47,013	16,597	8,971
3	Contract Costs	23,000	4,500	0	1,000	8,611
4	Equipment Costs	53,857	6,775	15,975	11,969	5,365
5	Equipment Maintenance (Mat'ls.)	50,000	3,750	3,760	1,430	1,118
6	Materials: Fertilizer, etc.	12,000	1,000	0	1,100	2,000
	Other	75,000	0	4,500	0	500
7	Cost of Maintenance	880,307	231,275	498,648	182,976	108,087
8	Adjusted Acres Maintained	156	70	110	41	31
9	Cost of Maintenance/Acre	5,642	3,304	4,533	4,463	3,487

RAW DATA ON INTERMENT AND MAINTENANCE UNIT COSTS

		CEMETERY CODE NO.				
ITEM	DESCRIPTION	HI-1	KS-1	MN-1	MO-1	NM-1
	INTERMENT					
1	Salaries	84,208	23,115	211,525	231,675	53,036
2	Benefits	9,263	2,543	23,268	25,484	5,834
3	Contract Costs	0	0	0	0	0
4	Equipment Costs	3,925	2,196	31,721	12,283	5,636
5	Equipment Maintenance (Mat'ls.)	125	1,900	17,000	4,500	3,500
6	Materials: Topsoil	0	0	0	275	0
	Seed, Fertilizer	0	5,200	6,000	10,000	2,500
	Lumber, etc.	300	600	150	900	600
7	Cost of Interments	97,821	35,554	289,664	285,117	71,106
8	Total Inground Interments	606	508	2,837	2,219	607
9	Cost of Interments/Gravesite	161	70	102	128	117
	MAINTENANCE					
1	Salaries	528,476	145,512	350,150	235,790	128,041
2	Benefits	58,132	16,006	38,517	25,937	14,085
3	Contract Costs	0	0	500	10,000	1,500
4	Equipment Costs	13,331	7,875	21,148	9,205	5,785
5	Equipment Maintenance (Mat'ls.)	200	3,500	7,000	4,500	4,500
6	Materials: Fertilizer, etc.	2,500	600	7,000	1,500	600
	Other	3,000	250	4,500	11,500	250
7	Cost of Maintenance	605,639	173,743	428,815	298,432	154,761
8	Adjusted Acres Maintained	65	36	142	125	21
9	Cost of Maintenance/Acre	9,318	4,826	3,020	2,387	7,370

RAW DATA ON INTERMENT AND MAINTENANCE UNIT COSTS

		CEMETERY CODE NO.				
ITEM	DESCRIPTION	NY-1	OR-3	PR-1	TN-1	TN-3
	INTERMENT					
1	Salaries	928,809	293,284	59,521	36,698	8,877
2	Benefits	102,169	32,261	6,547	4,037	977
3	Contract Costs	0	0	0	0	0
4	Equipment Costs	33,203	22,000	8,512	10,544	2,220
5	Equipment Maintenance (Mat'ls.)	72,567	7,250	1,792	2,500	175
6	Materials: Topsoil	64,315	360	0	0	0
	Seed, Fertilizer	8,975	15,000	2,455	1,825	0
	Lumber, etc.	10,000	500	0	450	100
7	Cost of Interments	1,220,038	370,655	78,827	56,004	12,349
8	Total Inground Interments	9,818	2,153	770	416	143
9	Cost of Interments/Gravesite	124	172	102	135	86
	MAINTENANCE					
1	Salaries	671,275	368,784	59,520	83,288	51,639
2	Benefits	73,840	40,566	6,547	9,162	5,680
3	Contract Costs	35,000	0	0	8,740	0
4	Equipment Costs	35,361	21,900	1,367	4,846	3,003
5	Equipment Maintenance (Mat'ls.)	73,000	7,250	--	8,200	500
6	Materials: Fertilizer, etc.	30,000	20,000	--	7,600	800
	Other	156,971	5,000	--	375	500
7	Cost of Maintenance	1,075,447	463,500	67,434	122,211	62,122
8	**Adjusted Acres Maintained**	345	90	63	99	25
9	**Cost of Maintenance/Acre**	3,117	5,179	1,079	1,241	2,485

RAW DATA ON INTERMENT AND MAINTENANCE UNIT COSTS

		CEMETERY CODE NO.				
ITEM	DESCRIPTION	TN-4	TN-5	TX-1	TX-2	TX-3
	INTERMENT					
1	Salaries	39,027	49,313	49,452	54,800	128,970
2	Benefits	4,293	5,424	5,440	6,028	14,187
3	Contract Costs	0	0	0	0	0
4	Equipment Costs	9,773	2,564	6,660	4,282	15,410
5	Equipment Maintenance (Mat'ls.)	1,800	1,546	6,928	3,500	8,000
6	Materials: Topsoil	0	4,355	2,085	0	2,200
	Seed, Fertilizer	200	1,350	4,800	0	5,700
	Lumber, etc.	25	600	3,139	850	6,500
7	Cost of Interments	55,118	65,152	78,504	69,460	180,967
8	Total Inground Interments	634	420	1,078	726	1,615
9	Cost of Interments/Gravesite	87	155	73	96	112
	MAINTENANCE					
1	Salaries	108,140	52,678	65,904	83,216	165,662
2	Benefits	11,895	5,795	7,249	9,154	18,223
3	Contract Costs	0	13,045	0	0	0
4	Equipment Costs	6,279	2,356	9,329	6,424	10,377
5	Equipment Maintenance (Mat'ls.)	7,500	844	14,954	2,400	12,518
6	Materials: Fertilizer, etc.	2,500	2,300	4,800	500	10,000
	Other	1,500	1,500	5,600	0	35,000
7	Cost of Maintenance	137,814	78,518	107,836	101,694	251,780
8	Adjusted Acres Maintained	44	63	45	43	63
9	Cost of Maintenance/Acre	3,132	1,256	2,396	2,365	3,997

RAW DATA ON INTERMENT AND MAINTENANCE UNIT COSTS

ITEM	DESCRIPTION	CEMETERY CODE NO. VA-2	 WI-1
	INTERMENT		
1	Salaries	14,400	63,992
2	Benefits	1,584	7,039
3	Contract Costs	0	0
4	Equipment Costs	2,671	7,601
5	Equipment Maintenance (Mat'ls.)	2,000	4,000
6	Materials: Topsoil	0	3,600
	Seed, Fertilizer	0	4,000
	Lumber, etc.	250	1,500
7	Cost of Interments	20,905	91,732
8	Total Inground Interments	193	648
9	Cost of Interments/Gravesite	108	142
	MAINTENANCE		
1	Salaries	31,360	92,968
2	Benefits	3,450	10,226
3	Contract Costs	0	2,500
4	Equipment Costs	4,013	2,726
5	Equipment Maintenance (Mat'ls.)	1,600	6,000
6	Materials: Fertilizer, etc.	1,000	3,000
	Other	1,000	10,000
7	Cost of Maintenance	42,423	127,420
8	Adjusted Acres Maintained	15	38
9	Cost of Maintenance/Acre	2,926	3,398

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APPENDIX D

TABLE OF DISCOUNT FACTORS

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DISCOUNT FACTORS

Year since initiation, renewal or expansion	Discount factors	Year since initiation, renewal or expansion	Discount factors
1	0.909091	26	0.083905
2	0.826446	27	0.076278
3	0.751315	28	0.069343
4	0.683013	29	0.063039
5	0.620921	30	0.057309
6	0.564474	31	0.052099
7	0.513158	32	0.047362
8	0.466507	33	0.043057
9	0.424098	34	0.039143
10	0.385543	35	0.035584
11	0.350494	36	0.032349
12	0.318631	37	0.029408
13	0.289664	38	0.026735
14	0.263331	39	0.024304
15	0.239392	40	0.022095
16	0.217629	41	0.020086
17	0.197845	42	0.018260
18	0.179859	43	0.016600
19	0.163508	44	0.015091
20	0.148644	45	0.013719
21	0.135131	46	0.012472
22	0.122846	47	0.011338
23	0.111678	48	0.010307
24	0.101526	49	0.009370
25	0.092296	50	0.008519

Source: Circular No. A-94 Revised March 27, 1972
Executive Office of the President
Office of Management and Budget
Washington, D.C. 20503

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APPENDIX E

DERIVATION OF APPROXIMATE EQUATIONS

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DERIVATION OF APPROXIMATE EQUATIONS
PRESENT VALUE OF LIFE CYCLE COSTS PER VETERAN FAMILY UNIT

Alternate No.	C Interment Structures	L + S Land and Site Development	I Interment	M Maintenance	Equation
0	$1.333\ U_o \cdot .687$	$\frac{15,000 + 35,000}{512}$	$1.333 \cdot 19,500 \times .687\ \frac{EI}{PI}$	$\frac{3700 \times 50 \times .198}{512}$	$.916\ U_o + 17862\ \frac{EI}{PI} + 169.20$
1	$1.333 \cdot 60 \cdot .687$	$\frac{15,000 + 35,000}{512}$	$1.333 \cdot 19,500 \times .687\ \frac{EI}{PI}$	$\frac{3700 \times 50 \times .198 \times F_s}{512}$	$152.61 + 17862\ \frac{EI}{PI} + 71.54\ F_s$
2	$1.333\ U_o \cdot .687$	$\frac{15,000 + 35,000}{427}$	$1.333 \cdot 19,500 \times .687\ \frac{EI}{PIX}$	$\frac{3700 \times 50 \times .198}{427}$	$.916\ U_o + 17862\ \frac{EI}{PIX} + 202.88$
3	$1.333\ U_o \cdot .687$	$\frac{15,000 + 35,000}{771}$	$1.333 \cdot 19,500 \times .687\ \frac{EI}{PIX}$	$\frac{3700 \times 50 \times .198}{771}$	$.916\ U_o + 17862\ \frac{EI}{PIX} + 112.36$
4	$U_x \cdot .875$	$\frac{15,000 + 35,000}{1057}$	$1.333 \cdot 50.00 \times .687$	$\frac{3700 \times 50 \times .198}{1057}$	$.875\ U_x + 127.76$
5	$1.333\ U_x \cdot .875$	$\frac{15,000 + 35,000}{1650}$	$1.333 \cdot 23.00 \times .687$	$1.333 \times 3.00 \times 50 \times .198$	$1.166\ U_x + 101.05$
6	$1.333 \cdot 60 \cdot .687$	$\frac{15,000 + 35,000}{1025}$	$1.333 \times 16.00 \times .687$	$\frac{3700 \times 50 \times .198}{1025} \times \frac{5.67}{PM}$	$118.38 + \frac{202.62}{PM}$
7	$U_x \cdot .875$	$\frac{15,000 + 35,000}{2100}$	$1.333 \times 10.00 \times .687$	$2.00 \times 50 \times .198$	$.875\ U_x + 52.77$
8	$U_x \cdot 1.000$	0	$1.333 \times 10.00 \times .687$	$2.00 \times 50 \times .198$	$U_x + 28.96$

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APPENDIX F

REFERENCES

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REFERENCES

2.1 "National Cemeteries Headstones and Markers — Program Evaluation," Draft Working Paper, March 1979.

3.1 "Report on National Cemeteries — Location and Status of Gravesites (Annual) — FY 1978," Veterans Administration National Cemetery System.

3.2 List entitled "FY 1978 Interments in Descending Order." Source: Veterans Administration.

3.3 "Report on National Cemeteries — Acreage Annual," Veterans Administration, National Cemetery System.

3.4 Cemetery Service (41C) August 3, 1979 Table V — Veterans in Civil Life Buried in National Cemeteries — Nationwide (1973-78).

3.5 "Estimated Maintenance Cost of a Grave With and Without Liner." Source: Veterans Administration, Office of Program and Planning Evaluation.

3.6 "V.A. Specification X-1708a, February 19, 1976." Source: Veterans Administration.

3.7 Veterans Administration Specification X-1708c, June 1, 1979, "Liners, Grave, Concrete and Thermoplastic/Thermosetting."

3.8 The questionnaires prepared for this study that were returned (from sixty-two of the national cemetery directors). (See Appendix A.)

3.9 Technical Mannual, TM 10-287, Administration, Operation and Maintenance, National Cemeteries; Headquarters, Department of the Army, August 1973.

3.10 a) "Open Space in Urban Design." A report prepared for The Cleveland Development Foundation, Cleveland, Ohio, 1964; pp. 66-67.

b) Handbook of Landscape Architectural Construction: Rooftop Development; Richard H. Rogers; 1975; pp. 7-10.

c) "Landscape Design with Plants." Editor: Brian Clouston; Heinemann, London, 1977; Chapter 9, Planting in Artificial Conditions.

5.1 Mausoleum/Columbarium Construction Cost Study, Willamette National Cemetery, Portland, Oregon. Prepared by Harley Ellington Pierce Yee Associates and William Roth, Revision of Sept. 29, 1976.

6.1 Part 101-47 of the Federal Property Management Regulations, Section 47.204-1, "Reported Property."

7.1 Ungraded Employee Hour Monthly Operating Reports, V.A. Form 40-4991, May 1977, for the 22 National Cemeteries analyzed in detail.

7.2 Workload Trend 1975-1981, a table of data prepared by the Department of Memorial Affairs.

8.1 "Criteria for Determining Need for Irrigation in National Cemeteries" including 5 pages of weather data prepared by the Office of Construction, Cemetery Facilities Division.

10.1 Office of Management and Budget Circular No. A-94, Revised March 27, 1972, Subject: Discount rates to be used in evaluating time-distributed costs and benefits.

10.2 Cemetery Service (41C) August 3, 1979, Table II — Dependents Represented in Total Interments by Region (1973-78).

10.3 R.S. Means Building Construction Cost Data, annually published by R.S. Means Co., Inc., Duxbury, Mass.

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APPENDIX G

FORMS FOR ANALYSES OF COST EFFECTIVENESS ALTERNATIVE METHODS OF INTERMENT

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National Cemetery: New York N. C.
Location: Suffolk Co., N.Y.

ANALYSES OF COST EFFECTIVENESS
ALTERNATIVE METHODS OF INTERMENT

FORM A - SUMMARY OF COST EFFECTIVENESS RATIOS

Alternate No. (1)	Description	Ref. Dwg.	Present Value of Life Cycle Cost	Cost Effectiveness Ratio (CER) (2)
			PV	PV0÷PVX
0	6'x10' W. Liners	SKL-0	PV0= 5,649,234	xxxxxxxxxxxxxxxx
1	Double Lawn Crypt	SKL-1	PV1= 5,212,662	1.08
2			PV2=	
3			PV3=	
4			PV4=	

(1) Alternate 0 is the control alternative with which Alternate X (=1, 2, etc.) is compared. It should be the existing method if one exists; otherwise, use the inground conventional method deemed most appropriate.

(2) A method is more cost effective than the control method when its CER is greater than 1.00. This economic comparison is equivalent to the benefit-cost ratio method set forth in OMB Circular A-94 and conforms to all the guidelines of that document.

Brief Description of Area and Alternatives Compared: 12 ± Low-Lying acres with the water table at 5 to 6' depth being compared for advantage of double depth lawn crypts over 6'x10'x5' gravesites with box liners, the method currently employed because of collapsing sands. 12,000 crypts would be constructed to last 4 years, 6000 in year 0 and 6,000 in year 2.

Conclusion: Preplaced double depth lawn crypts will have a present value of life cycle costs 8% lower than 6'x10' gravesites.

Prepared by: R. Heimbuch
Clarke and Rapuano Inc.
Date: 2-13-80

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FORM B - PRESENT VALUE OF LIFE CYCLE COSTS

ALTERNATE NO. 0

Cemetery: New York N.C.
Section of Cemetery Being Analyzed: High Ground Water Zone - S.W. Quadrant
Description of Interment Method: 6'x10' Gravesite with Box Liner
☒ Method will be used exclusively for future interments, or
☐ Method will be used simultaneously with ____________ method.

DATA

Symbol	Item	Operation	Current Value	Unit
D	Density (1)	From plan	427	Gravesites/Gross Ac. ~~Burial Units/Gross Ac.~~
NI	First Interments For Y= 4 years (2)		12,000	No.
NR	Reopeners	NI/3	4,000	No.
NI+NR	No. of Interments	NI+NR	16,000 *	No.
	No. of Interment Structures	~~NI~~ or NI+NR(3)	16,000 *	No.
PI	Interment Productivity Rate(4)		156	Interments/Man-Yr.
PM	Maintenance Productivity Rate		7.7	Maintained Ac**/Man-Yr.
AI	Annual Interment Salary		16,500	$
AM	Annual Maintenance Salary		13,700	$
EI	Interment Escalation Index	AI/$14,400	1.15	Dimensionless
EM	Maintenance Escalation Index	AM/$13,000	1.05	Dimensionless
	Gross Acres	NI/D or ~~(NI+NR)/D~~ (3)	28.10 *	Gross Acres
	Unit Cost-Interments	$19,500(EI/PI)	143.75 *	$/Each
	Unit Cost-Maintenance(50 yrs)	$17,000(EM/PM)50	115,909 *	$/Acre

* Data required for present value calculations.

** 100% of Gross acres with markers in place + 50% of gross acres maintained without markers.

PRESENT VALUE CALCULATIONS

Symbol	Item	Quantity	Unit	Current Unit Price	Discount Factor, K(5)		Present Value
		Q		U	Y=5	Y= 4	QxUxK
C	Interment Structures	16,000	Each	(6) 170		.717	1,950,240
L	Land	28.10	Acre	15,000 (7)	1.00	1.00	421,500
S	Site Development	28.10	Acre	(8) 35,000	1.00	1.00	983,500
I	Interments	16,000	Each	143.75	.687	.717	1,649,100
M	Maintenance	28.10	Acre	115,909	.198	.198	644,894

Present Value of Life Cycle Cost $5,649,234

FORM B - NOTES

(1) Use number of gravesites or burial units to be constructed divided by the number of gross acres consumed, where gross acres = 1.70[*] x the number of net acres disturbed in constructing the gravesites or burial units, including all related special site work but excluding access roads and buffer areas.

(2) If the area being considered will accommodate 5 years or more of first interments using the alternative[**] having the lowest density per gross acre, use Y = 5 years for all alternatives and allow the gross acres of each alternative to vary in proportion to its density. If the area will accommodate less than 5 years of first interments, use the nearest whole number of years for all alternatives and adjust K values accordingly.

(3) Use the following for the number of interment structures and gross acres.

Method	Interment Structures	Gross Acres
Inground without liners	NI + NR[***]	NI/D
Inground with liners	NI + NR	NI/D
Preplaced multiple lawn crypts	NI	NI/D
Garden crypts	NI + NR	(NI + NR)/D
Columbaria niches	NI	NI/D

(4) Use actual productivity rate where available. Otherwise refer to Table 9-1 for guidance. When this method is to be employed in one part of the cemetery while the present method is being used simultaneously elsewhere, use the present productivity rate if it is lower than the productivity rate of the alternative method being considered.

(5) Discount factors for interment structures assuming 5 years of first interments are given in Table 10-2. For any other number of years, use Form C to calculate the actual discount factors, using Appendix D and the method indicated in Table 10-2.

(6) Include special sitework specifically related to this alternative. Include the unit cost of markers where they are separate from the interment structure.

(7) The market value of reasonably low-priced land in the same community suitable for cemetery development. In the absence of specific data, use $_____/acre.

(8) Excluding buildings. In the absence of specific data, use $_____/acre.

[*] Unless another specific ratio exists for the cemetery or a major portion of it.

[**] not including the existing interment method if that method will be continued simultaneously in other parts of the cemetery.

[***] Markers only.

FORM B - PRESENT VALUE OF LIFE CYCLE COSTS

ALTERNATE NO. 1

Cemetery: New York, N.C.
Section of Cemetery Being Analyzed: High Ground Water Zone - S.W. Quadrant
Description of Interment Method: Double Depth Lawn Crypts, 3' avg. excav., with underdrains
☒ Method will be used exclusively for future interments, or
☐ Method will be used simultaneously with ______ method.

DATA

Symbol	Item	Operation	Current Value	Unit
D	Density (1)	From plan	1,057	Gravesites/Gross Ac. ~~Burial Units/Gross Ac.~~
NI	First Interments For Y= 4 years (2)		12,000	No.
NR	Reopeners	NI/3	4,000	No.
NI+NR	No. of Interments	NI+NR	16,000 *	No.
	No. of Interment Structures	NI ~~or NI+NR(3)~~	12,000 *	No.
PI	Interment Productivity Rate (4)		390	Interments/Man-Yr.
PM	Maintenance Productivity Rate		7.7	Maintained Ac**/Man-Yr.
AI	Annual Interment Salary		16,500	$
AM	Annual Maintenance Salary		13,700	$
EI	Interment Escalation Index	AI/$14,400	1.15	Dimensionless
EM	Maintenance Escalation Index	AM/$13,000	1.05	Dimensionless
	Gross Acres	NI/D or ~~(NI+NR)/D~~ (3)	11.35 *	Gross Acres
	Unit Cost-Interments	$19,500(EI/PI)	57.50 *	$/Each
	Unit Cost-Maintenance(50 yrs)	$17,000(EM/PM)50	115.909 *	$/Acre

* Data required for present value calculations.
** 100% of Gross acres with markers in place + 50% of gross acres maintained without markers.

PRESENT VALUE CALCULATIONS

Symbol	Item	Quantity	Unit	Current Unit Price	Discount Factor, K(5)		Present Value
		Q		U	Y=5	Y=4	QxUxK
C	Interment Structures	12,000	Each	(6) 340		.913	3,725,040
L	Land	11.35	Acre	15,000 (7)	1.00	1.00	170,250
S	Site Development	11.35	Acre	(8) 35,000	1.00	1.00	397,250
I	Interments	16,000	Each	57.50	.687	.717	659,640
M	Maintenance	11.35	Acre	115,909	.198	.198	260,482
				Present Value of Life Cycle Cost			$ 5,212,662

FORM B - NOTES

(1) Use number of gravesites or burial units to be constructed divided by the number of gross acres consumed, where gross acres = 1.70[*] x the number of net acres disturbed in constructing the gravesites or burial units, including all related special site work but excluding access roads and buffer areas.

(2) If the area being considered will accommodate 5 years or more of first interments using the alternative[**] having the lowest density per gross acre, use Y = 5 years for all alternatives and allow the gross acres of each alternative to vary in proportion to its density. If the area will accommodate less than 5 years of first interments, use the nearest whole number of years for all alternatives and adjust K values accordingly.

(3) Use the following for the number of interment structures and gross acres.

Method	Interment Structures	Gross Acres
Inground without liners	NI + NR[***]	NI/D
Inground with liners	NI + NR	NI/D
Preplaced multiple lawn crypts	NI	NI/D
Garden crypts	NI + NR	(NI + NR)/D
Columbaria niches	NI	NI/D

(4) Use actual productivity rate where available. Otherwise refer to Table 9-1 for guidance. When this method is to be employed in one part of the cemetery while the present method is being used simultaneously elsewhere, use the present productivity rate if it is lower than the productivity rate of the alternative method being considered.

(5) Discount factors for interment structures assuming 5 years of first interments are given in Table 10-2. For any other number of years, use Form C to calculate the actual discount factors, using Appendix D and the method indicated in Table 10-2.

(6) Include special sitework specifically related to this alternative. Include the unit cost of markers where they are separate from the interment structure.

(7) The market value of reasonably low-priced land in the same community suitable for cementery development. In the absence of specific data, use \$_____ /acre.

(8) Excluding buildings. In the absence of specific data, use \$______/acre.

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[*] Unless another specific ratio exists for the cemetery or a major portion of it.

[**] not including the existing interment method if that method will be continued simultaneously in other parts of the cemetery.

[***] Markers only.

FORM C - ALTERNATIVE DISCOUNT FACTORS

	Cost Item	Year(s) in which cost is incurred (1)	Average Discount Factor(2)	Fraction of Total	Weighted Discount Factor, K
(a)	Interments, First Burials	1 - 4	.792	.75	.594
(b)	Interments, Reopenings	6 - 9	492	.25	.123
(c)	Interments, Total			1.00	.717
(d)	Liners and Markers	Same as interments		1.00	.717
(e)	Crypts or niches	0	1.000	.50	.500
		2....	.826	.50	.413
		....	.....	1.00	.913

FORM C - NOTES

(1) (a) Construction of site development and the first phase of crypts and niches is assumed to occur in year 0. Interments begin in year 1.

(b) In the absence of specific data to the contrary use 1 through Y years for first burials and 6 through (5 + Y) years for reopenings.

(c) If lawn crypts, garden crypts, columbaria niches or other interment structures having a high initial cost are to be constructed in two or more construction phases, assign a year to each phase and indicate the appropriate discount factor for that year and what fraction of the total cost it represents.

(2) From Appendix D, based on a 10% interest rate (OMB Circular A-94). For a uniform number of annual interments use the average K value for the years indicated.

*U.S. GOVERNMENT PRINTING OFFICE : 1980 O-311-644/2858